DOCUMENT RESUME

ED 270 850 EA 018 528

AUTHOR Gibbens, Trevor P.
TITLE The Administrative Impact of Computers on the British Columbia Public School System.
PUB DATE 86
NOTE 287p.; Master's Thesis, University of British Columbia.
PUB TYPE Dissertations/Theses - Master Theses (042) -- Reports - Descriptive (141)

EDRS PRICE MF01/PC12 Plus Postage.
DESCRIPTORS Centralization; *Computer Managed Instruction; *Computers; Data Collection; *Educational Administration; *Educational Policy; Elementary Secondary Education; Foreign Countries; Government School Relationship; Information Processing; *Management Information Systems; Organizational Communication; Public Schools; State School District Relationship
IDENTIFIERS British Columbia

ABSTRACT

This case study analyzes and evaluates the administrative computer systems in the British Columbia public school organization in order to investigate the costs and benefits of computers, their impact on managerial work, their influence on centralization in organizations, and the relationship between organizational objectives and the design of computer systems. The study is based on (1) analysis of past and present policy developments, (2) interviews with 23 educational administrators at the provincial, district, and building level, and (3) interviews with representatives of educational agencies and the commercial sector. Findings suggest that the use of computers at all levels of the school system leads to increased control at each of those levels, but that the largest increase in control accrues to the Ministry of Education. Highly computer-dependent monitoring systems, in the form of a Planning, Programing and Budgeting System (PPBS), along with provincial examinations and achievement tests, are the chief vehicles of control. Barriers to the design and implementation of a provincially distributed data processing system in British Columbia include (1) hardware and software incompatibility among districts and between districts and the Ministry of Education; (2) lack of a firm ministry commitment to standardization, resulting in redundancy and duplication of services; (3) school district resistance to central direction in data processing; and (4) financial constraints. Parallel to, but unconnected with this project, teacher and school trustee organizations also introduced new central office systems, using computerization to reduce expenditures and increase organizational control. A glossary, a bibliography, and seven appendixes are included. (TE)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

☒ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

Trevor Gibbens

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

ED270850

THE ADMINISTRATIVE IMPACT OF COMPUTERS ON THE BRITISH COLUMBIA PUBLIC SCHOOL SYSTEM

by

TREVOR P. GIBBENS

B.Ed., The University Of British Columbia, 1982

A THESIS SUBMITTED IN PARTIAL FULFILMENT OF

THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF ARTS

in

THE FACULTY OF GRADUATE STUDIES

Department Of Administrative, Adult And Higher Education

We accept this thesis as conforming

to the required standard

Paul C. Gilmore .....

.....

Daniel J. Brown .....
Research Supervisor

THE UNIVERSITY OF BRITISH COLUMBIA

March 25, 1986

© TREVOR P. GIBBENS, 1986

EA 018 528

ABSTRACT

This case study analyzes and evaluates the administrative computer systems in the British Columbia public school organization. Historic and contemporary policy developments are scrutinized. Research sources include interviews with twenty-three educational administrators representing the Ministry of Education, six school districts and five schools. Respondents from educational agencies and the commercial sector were also interviewed. Research documents range from policy statements and correspondence to financial data and internal studies.

Four closely related questions serve as the study's focus: 1.) What are the cost-benefits of computers? 2.) What is the impact of computers on managerial work? 3.) Is computerization associated with centralization in organizations? 4.) What is the relationship between organizational objectives and the design of computer systems?

After a twenty-five year history involving relatively slow development, computing facilities are undergoing a rapid transition at all levels of the British Columbia public school system. The transition is driven by rapidly advancing technologies, manufacturers' strategies, and policies fostered by Cabinet, the public service, and the Ministry of Education. Between 1980 and 1984, a significant expansion in the administrative use of computers occurred throughout the school system.

The new school district computerization policy, while designed to enhance Ministry control over district finances by supporting a Planning, Programing and Budgeting System (PPBS), is in its implementation, considerably less centralized than many other public service electronic data processing systems (EDP).

The administrators experienced direct and indirect effects of computerization. Direct effects were noted at the lowest rank, where some vice-principals entered and retrieved data on microcomputers. At higher ranks, computer terminals were not observed in the personal offices of administrators. No educational managers senior to that of vice-principal operated a computer in their work. The largest indirect effect arose from increased central control. As the financial and educational performance of schools and school districts comes under increasing scrutiny with the assistance of large-scale computerized monitoring, administrative action at these levels becomes more constrained.

Centralization is enhanced by computers. The educational organization's current centralization program has resulted in a degree of control not exercised by the Ministry since the 1950's. The use of computers at all levels of the school system leads to increased control at each of those levels, but the largest increase in control is exerted by the Ministry. Highly computer dependent monitoring systems, in the form of PPBS, and provincial examinations and achievement tests, are the chief control vehicles.

Optimal solutions to the design and implementation of a provincial distributed data processing system are not manifested in the British Columbia educational organization. Hardware and software incompatibility among districts, and between districts and Ministry encumber electronic communications. Full networking and cost-effective development of system components cannot be realized within the present provincial configuration. Some financial information is presented as a basis for indicating the system's operating and capital costs.

Lack of a firm Ministry commitment to standardization resulted in redundancy, duplication of services, and an inability to exploit the potential of a large 1982-1985 investment. School district resistance to central direction in data processing spans almost two decades and has contributed to system fragmentation. Loss of Ministry of Education EDP professionals in the wake of the 1977 centralization of all government data processing facilities, and the 1983 imposition of financial restraint contributed to the Ministry's failure to take complete charge of the district computer project.

Parallel to, but unconnected with this project, teacher and school trustee organizations also introduced new central office systems. As administrators within these different precincts strove to decrease operating costs, computerization was viewed as a significant means of reducing expenditures and increasing organizational control.

Daniel J. Brown

ACKNOWLEDGMENT

I wish to thank Dr. Daniel Brown for his supervision in the preparation and writing of this thesis. I also thank Dr. John Andrews and Dr. Paul Gilmore, the other committee members, for their encouragement and criticism.

The cooperation of interviewees and correspondents in the British Columbia public education system, the public service, and the commercial sector made this research possible. A special thanks to my mother, Mrs. Betty Gibbens, who typed the interview transcripts and helped to edit the thesis. Project completion was facilitated by a University Graduate Fellowship.

ACRONYMS

BCRC British Columbia Research Council

BCSC British Columbia Systems Corporation

BCSTA British Columbia School Trustees Association

BCTF British Columbia Teachers' Federation

BOSS Basic Operating System Software

CBM Commodore Business Machines

CCITT Comité Consultatif Internationale de Telégraphique et Téléphonique

CEMCORP Canadian Educational Microprocessor Corporation; CEMCORP International

CIPS Canadian Information Processing Society

CPF Control Program Facility

CPS Characters per second

CPU Central processing unit

DEC Digital Equipment Corporation

DOS-VSE Disk Operating System - Virtual Storage Extended

DP Data processing

EDP Electronic data processing

ERIBC Education Research Institute Of British Columbia

GCOS General Comprehensive Operating System

IBM International Business Machines Corporation

IDC International Data Corporation (Canada) Limited

ILO International Labour Organization

LAN Local area network

MAI Management Assistance Incorporated

MIS Management information system

NCR National Cash Register Of Canada Limited; NCR Limited

PC personal computer; Personal Computer (IBM product)

PPBS Planning, Programing, and Budgeting System

RSTS-E Resource Sharing, Time Sharing – Extended

SDLC Synchronous Data Link Control

SIPRI Stockholm International Peace Research Institute

SNA Systems Network Architecture

UNESCO United Nations Educational, Scientific, And Cultural Organization

VAX/VMS Virtual Address Extended/Virtual Memory System

VS Virtual Storage

Table of Contents

ABSTRACT iii

ACKNOWLEDGEMENT vi

ACRONYMS vii

I. INTRODUCTION 1

A. THE PACE OF TECHNOLOGICAL CHANGE 1

B. BACKGROUND TO THE STUDY 4

C. THE BRITISH COLUMBIA PUBLIC SCHOOL ORGANIZATION 5

D. AN OUTLINE OF THE STUDY 6

1. Research Questions 7

2. Research Design 7

3. Organization of Topics 8

II. REVIEW OF THE LITERATURE 9

A. CENTRALIZATION AND DECENTRALIZATION 10

B. CAUSE AND EFFECT 14

C. COMPUTERS AND CENTRALIZATION 18

1. Informatics and Administration 22

2. The Relationship Between Organizational and Computer Programing Hierarchies 25

D. DECENTRALIZATION AND THE NEW TECHNOLOGY 26

1. Ambiguity of Computer-Based Decentralist Position 27

2. Microcomputer Autonomy Absorbed by Networks 28

3. The Market as a Determinant of Organizational Impact 31

E. PLANNING, PROGRAMING, AND BUDGETING SYSTEMS 37

1. Role in Public Education 41

a. The United States of America 43

b. Canada 46
c. British Columbia 49
2. PPBS Overview 54
F. SUMMARY OF THE LITERATURE REVIEW 55
III. METHODOLOGY 57
A. SAMPLING TECHNIQUES 60
B. PILOT STUDY 62
C. CANDIDATE SELECTION 63
D. CANDIDATE PROFILES 64
E. THE INTERVIEWS 68
1. Interview Schedule 71
2. Respondent's Consent 72
3. Tape Recording 73
4. Transcripts 75
F. Interviewer Bias And Respondent Validity 76
G. SUMMARY 78
IV. RESEARCH FINDINGS 79
A. MINISTRY OF EDUCATION 82
1. Changing Role of EDP 85
2. Computing Expenditures and Cost Analysis ...87
3. Ministry's School District Computer Acquisition Policy 92
4. Management Information Systems 93
5. Repatriation of Electronic Data Processing? 95
6. Computing Facilities in Transition 96
7. Were BCSC's Systems Development Charges Too High? 97
8. Multiple Keyboard Entry of Data 98

9. Electronic Transmission of Data 100

10. Summary 101

B. SCHOOL DISTRICT 102

1. 1969 Plan for Regional Data Processing Centres 102

2. 1978 School District Computer Needs Report 104

3. Computer Systems in the Research Sample ...108

4. Increased Ministry Control 109

5. Decentralization of District EDP Services .115

6. Capital and Operating Costs 118

7. Software Development 122

8. Processing Capacity Soon Exhausted 124

9. Flat Organization 127

10. The 1983 Planning, Programing, and Budgeting System 131

11. Summary 134

C. SCHOOL 135

1. Formal Communication of Experiences with Computers 136

2. Types of Computer Services 137

3. Student Management Microcomputer Programs .138

4. Transfer of Costs 140

5. Indirect Labour Costs 142

6. Data Retrieval 149

7. Preference for District Office Star Network 152

8. Field Testing 154

9. Organizational Conflict 155

10. Computers and Centralization 156

11. Summary 157

D. BRITISH COLUMBIA SYSTEMS CORPORATION 158

1. Standardization On SNA 160

2. Ministry of Education Included in Centralized Service 162

3. School District Response 164

4. BCSC Prevails 164

5. Corporate Control of Microcomputers 165

6. Treasury Board Attempts to Sell BCSC 167

7. Summary 171

E. Recapitulation 171

V. CONCLUSION 174

A. Conclusions 174

1. Cost-Benefit Analysis 175

2. Managerial Impacts 177

3. Centralizing Effects 179

4. Organizational Objectives And Computer Systems Design 181

B. RESEARCH IMPLICATIONS 183

1. Costs and Cost-Benefits 183

2. Inter-provincial Cooperation 185

3. Administrative Computers and Educational Diversity 185

4. Middle Management – Candidates for Computerization? 186

C. POLICY RECOMMENDATIONS 186

1. Ministry Coordination of EDP Purchases 187

2. Standardize Informatics Components 188

3. Common Operating System 188

4. Use BCSC Communications Network 188

5. Transmit Data Electronically 189

6. Establish a Division of Informatics 190

7. Retain Ownership of Software Developed Under Contract 190

8. Institute Full Informatics Accounting Practices 191

9. Seek Cooperation Between Provincial Ministries of Education 192

D. AFTERWORD 193

GLOSSARY 196

BIBLIOGRAPHY 200

APPENDICES 233

A. Time Line: Administrative Computers And The British Columbia Public Education System 233

B. 1982 Computer Acquisition Program For School Districts 238

C. Consequences Of Extra-national Capital Outflow – Generated By Informatics Purchases – On Educational Finance 253

D. The British Columbia Ministry Of Health Expert System 256

E. The Informatics System Of The Quebec Ministry Of Education 257

F. Schedule Of Questions 262

G. Notice Of Consent 268

BIOGRAPHICAL INFORMATION 269

TABLES

Number		Page
I	United States Expenditures On Public Education And Defense, 1980 – 1985	47
II	Interview Respondents By Position And Organizational Level	69
III	B.C. Ministry Of Education Computer Costs Compared With Total Public Education Expenditures, 1977 – 1984	89
IV	Computer Manufacturers, Models And Operating Systems Represented In The 1984 District Sample	107
V	Standard Equipment For Fourteen Member Consortium Of Small School Districts	111
VI	British Columbia School District Central Office Computers By Manufacturer, 1973 – 1981	113
VII	British Columbia School District Central Office Computers By Manufacturer, 1982 – 1985	128
VIII	British Columbia Systems Corporation Financial Performance, 1979 – 1984	168

FIGURES

Number		Page
I	Major Components Of The Program Accounting And Budgeting System - Fiscal Year 1983/84 - British Columbia Ministry Of Education	51
II	Respondents Mean Years Of Experience In Present Position By Organizational Level	65
III	Respondents Mean Years Of Educational Employment Experience By Organizational Level	65

$sig

I. INTRODUCTION

A. THE PACE OF TECHNOLOGICAL CHANGE

Canada faces a new technological challenge, either rapidly integrate microelectronics, or be integrated within a geopolitical entity that has. Serafini and Andrieu stress the important role which this technology plays:

> A number of recent studies... reflect the experts' growing belief that *Canada must exploit the new information technologies if it is to maintain some degree of economic, technological, political and cultural sovereignty in the future.* [authors' emphasis] (1981:7).

The pace of computer related change is accelerating. A good measure of the acceleration rate is the number of computer terminals installed each year in Canada. Over 120,000 terminals were installed in 1980 (Communications Canada 1983: 13). This figure represents one terminal for every fifty-six white-collar workers.[1] The number of terminals installed annually is expected to reach 511,000 by 1987, with a total value of 1.5 billion dollars (1983:13).[2]

There is a need for rapid technological assimilation in the administration of provincial public school organizations. How well the public education system makes the

---

[1] There were 6.7 million white-collar employees in 1980. (Statistics Canada 1980:90).

[2] In 1983, the United States ratio was one keyboard for every five white-collar employees. The anticipated 1985 ratio is one in three, with an expectation of one terminal for each employee by the year 2000. (Barna 1985:19).

transition to a computer intensive administration will affect the system's financial capacity to support a full complement of educational services.

Correspondence in 1983 from senior personnel representing several provincial ministries of education indicates that Canada's public education organizations have not only adopted separate system designs, but are also at different stages in systems development. Cooperation among ministries in the area appears virtually nonexistent. Some ministries possess fairly advanced electronic information networks; of these, Quebec's is one of the most sophisticated (Appendix E).

In 1982, the Quebec network had 132 online[3] school organizations, (definitions for most terms relating to computers are found in the Glossary. A list of acronyms appears before the Table of Contents) and serviced 250 school districts, making the system one of the largest in the world (Ball 1984:38). The Ministère de l'Éducation produced software for collective use throughout the province (Kirby 1983a). Ontario was moving toward the introduction of a provincial educational administration electronic network. This province was already well advanced with the design and manufacture of microcomputers for teaching and administrative use (McLean 1983:3).

A tendency exists in some Canadian education precincts to develop administrative computerization policies which

[3] Online: operation of a functional unit when under the direct control of the computer (Canada 1984:O-2).

only superficially consider the hard-won experience of other provinces. For their part, ministries with advanced systems have not made their knowledge of computerization a matter of detailed public disclosure. When each education ministry relies solely on the examination of its past experience and the commercially motivated advice of the business sector [4] as the foundation of computer policy, provincial independence can deteriorate into retrogressive isolationism. The implementation and operation of ill-conceived administrative informatics[5] produces substantial extra costs which arise from undelivered services, restrictive planning horizons, incompatible software and hardware, and duplicated effort among units.

Many of the problems associated with informatics are neither easily anticipated nor quickly solved. Throughout North America, specialists are in short supply (Denning, Feigenbaum, Gilmore et al 1981). Canada's shortage of experts is especially acute (Ören, Brzozowski, Gilmore et al 1983:24). Faced with this reality, and the scarcity of detailed independent studies of electronic information

---

[4] This problem is not confined to education ministries. Wills found, "Small and medium-sized Canadian companies (100-500 employees) rely excessively on suppliers (usually agents of foreign owned multinationals) [sic] who have a vested interest in selling particular and perhaps inappropriate products as a source of technical information." (1979:18).

[5] Informatics is the study of information and its handling, especially by means of new information technology, such as computers and telecommunications (Medows 1982:90). The term originates with A. I. Mikhailove, a Russian communications theorist (Garfield 1986).

systems operated by provincial school organizations, ministries are often forced to depend on inadequate resources for the planning, implementation and evaluation of informatics. Research of these systems is overdue. This study of the development and impact of administrative informatics in the British Columbia public school system is an initial step toward fulfilling this need.

B. BACKGROUND TO THE STUDY

Few studies have investigated the computer systems of provincial public education organizations (kindergarten to grade twelve). Academic research has focused mainly on the school (Bird 1983 & 1984; Marshall 1982; Ragsdale 1982; Westrom 1982b; Brown & Reusse 1983; Gatley 1984; Binns & Brown 1985), and to a lesser extent the school district (Anderson 1967; Roney & Perry 1976). A dearth of studies is found at the provincial and state levels.[6] As prospective research subjects, schools and school districts constitute more easily managed and comprehended subjects than their parent organization, the provincial ministry of education.

The complexity of organizational behaviour increases according to the educational unit's location in the administrative hierarchy. At the lowest level, the school interacts with school board office and the ministry. At the

[6] In September, 1985, a search of the United States electronic data bases, Research In Education, and Current Index To Journals In Education, using the descriptors "State Departments of Education and Administration and Computers or Electronic Data Processing" produced only two relevant titles.

highest, the ministry of education interacts with schools, school districts, school boards, other ministries, government agencies, cabinet, the legislative assembly, and the federal government. Comprehending the process of computerization relative to provincial educational governance is especially challenging. Research here, however, has a potentially larger impact, since economies of scale make possible new services and greater cost-benefits.[7]

C. THE BRITISH COLUMBIA PUBLIC SCHOOL ORGANIZATION

The first British Columbia Ministry of Education computer, when installed in 1961 (Annual Report 1961-62:47), was among less than one thousand computers operating in Canada (Serafini & Andrieu 1981:21). The twenty-fifth anniversary of the introduction will be marked in 1986. Over the intervening decades, computers moved from the Ministry's bureaucratic periphery to its administrative core.

During the 1960's, computers performed Ministry tasks, such as tabulating provincial examinations, which previously were accomplished by clerks. Today, computers model detailed personnel, financial and demographic data to predict changes in a variety of functions, including learning

[7] The importance of scale is cited in a 1983 federal report by the Telecommunications Agency on the feasibility of a shared network that will meet public service data transmission and messaging requirements. The study found "that the government could benefit from economies of scale if it consolidated data networks in a manner similar to its consolidation of voice networks." (Communications Canada Annual Report 1983-84, page 86).

assessment, teacher supply and demand, and property taxation. Assisted by electronically manipulated information, planners guide educational policy. From a solitary location in the Ministry, this equipment by 1983 had dispersed to all school district central offices. Today, the dispersion continues as many school offices acquire computing technology for the first time.

D. AN OUTLINE OF THE STUDY

The thesis assesses the development of computer systems within the British Columbia public school system and their impact on administration. Research methods were derived from the sociological literature on the implementation and effects of computers in commerce and government (Deardon 1966; Mowshowitz 1976; Kraemer & King 1977a; Frantzich 1982; Danzinger et al 1982; de Sola Pool 1983; O'Higgins 1984). The computer has a complex impact on organizations and the people in them. At all application levels, consideration of the interaction of the computer with the surrounding social system is essential (Sheingold, Krane & Endreweit 1983). How this interaction alters over time, as computing activities affect the organization, and the organization shapes computing technology, is of central concern to this study.

1. Research Questions

Administrative policies on electronic data processing in education organizations is influenced by social, economic and political processes in which educational governance takes place. To date, school administrators have largely escaped the operational research activities that have modified the work of many of their public service and business counterparts. Changes in these sectors are amplified due to the intensity with which computers have been applied to managerial work. Four closely related questions arising from the study of computer generated change provide a springboard for the line of inquiry adopted in this study.

1. What are the cost-benefits of computer systems?
2. What is the impact of computers on managerial work?
3. Is computerization associated with centralization in organizations?
4. What is the relationship between organizational objectives and the design of computer systems?

2. Research Design

The study is a synthesis of information derived from diverse qualitative and quantitative sources. Main data sources include interviews, correspondence, financial records, and public and private documents. Twenty-eight semi-structured interviews were conducted with educational administrators from the B.C. public school system. Interview respondents included vice-principals,

secretary-treasurers, superintendents, and department directors within the Ministry of Education. In each case, verbatim typed transcripts were prepared. Interviews were also undertaken with presidents, managers and marketing representatives of software and hardware firms serving the British Columbia educational administration market.

3. Organization of Topics

A list of acronyms precedes the Table of Contents. The theory pertaining to the organizational and administrative effects of computers is discussed in Chapter Two. Since the field of informatics is undergoing a succession of rapid changes, the discussion includes references to recent social, economic and technical developments. Chapter Three explicates the research methods. Findings are reported in Chapter Four for three organizational levels: Ministry of Education, school district and school. Findings for the British Columbia Systems Corporation (BCSC), a provincially owned Crown corporation which has influenced the development of educational data processing, are also recorded in Chapter Four. This chapter ends with a recapitulation of the findings. The conclusions are set forth in Chapter Five. Implications for further research and policy recommendations are presented at the end of Chapter Five. A Glossary located at the back of the work includes definitions of important technical terms. Finally, there is an Appendices section.

II. REVIEW OF THE LITERATURE

The review begins with a discussion of centralization and decentralization as organizational concepts. Centralization is then examined in relation to computers. Of particular relevance is the proposition, now several decades old, that computerization acts as an autonomous element to accelerate centralization. In recent years, attention has shifted from this deterministic view to whether, with careful design and implementation, computerization will support decentralization. The practicality of this instrumental relationship is discussed in the context of current marketing trends.

The postulation of a free market model in computer products allows the explanation for centralizing effects to be chiefly located in the decisions on equipment design taken by the purchasing organization. In sharp contrast, is the model of the planned economy where the informatics market is an extension of long-range strategies formulated by the world's leading computer manufacturer. According to this model, the centralizing effects found in client organizations assist the original equipment manufacturer to attain long-term corporate goals. Both of these models are reviewed.

Observing how computers are used is of overriding consequence to a determination of their administrative impact. In British Columbia, one of the most significant provincial

education applications is to process data for a new budgeting and accounting system. This system is derived from the Planning, Programing, and Budgeting System (PPBS), a cost-benefit methodology which has been attempted with quite limited results by various federal, provincial and local governments. The history of PPBS and the relevance of an operations model to public education is examined.

A. CENTRALIZATION AND DECENTRALIZATION

Centralization denotes a high concentration of power measured by criteria of weight, scope and domain (de Grazia 1964:81). An administration is centralized to the extent that decisions are made at relatively high levels in the organization (Simon et al 1954:1). The meaning of centralization is closely associated with other key organizational concepts, among them control, discipline, autonomy, hierarchy, integration, and coordination. With these words, discussion of centralization and decentralization is possible without ever actually mentioning the terms (de Grazia 1964: 81).

In an absolute sense, centralization and decentralization occupy opposite ends of a continuum. The position which an administrative unit holds along this continuum is gauged by the degree of autonomy that is exercised relative to other parts of the same organization or to other agencies. At the centralization end, power is concentrated in the organizational apex. At the decentralization end, power

is dispersed among subordinates. Rarely do organizations conform to these absolutes. The exercise of authority is in constant flux. On separate issues, and at different times, the power locus shifts.

Arriving at a generally agreed upon understanding of these terms is complicated by the historical associations which they hold. Decentralization is commonly advocated as a precondition for the achievement and preservation of a free society (Fesler 1968:371). Among contemporary democracies, centralization may bear a popular negative connotation, due to the term's close historical association with the growth of royal absolutism and the rise of the modern oligarchical state (Shepard 1963:308). While acknowledging the importance of these political associations, this study follows the empirical orientation of Kochen and Deutsch (1980:17) who find, "decentralization is not a value in itself. Our key values are quick responsiveness, reliability, adequacy, and quality of the needed or requested service. In this view, a service system will be more efficient with more of these values delivered at a lower cost."

Over thirty years have elapsed since the first business application of a computer. Centralization effects concerned observers from the beginning. In January, 1954, a computer was delivered to the Kentucky division of General Electric for accounting and business operations. Two articles published the same year, one by Higgins and Glickauf in March, the second by Osborn in July, reported on the General

Electric initiative. Each predicted that increased centralization would result. Leavitt's and Whisler's 1958 article *Management in the 1980's* prophesied that computers would lead to centralization. In time this relationship was accorded the status of an organizational axiom.

Two factors make a determination of the degree of centralization less simple than might otherwise be the case. Firstly, substantial decisions are often made by adhoc committees whose members may be drawn from all levels of the administrative hierarchy (Galbraith 1978:66). Secondly, administrative workload is not necessarily an indication of substantial discretionary power.

The attribution of significant decision-making power to a particular individual within a modern organization is in most cases a conventional fiction. Questions beyond the scope of organizational routine are usually determined by committee (Galbraith 1978:66). Decision-making passes down the hierarchy to find the level of relevant expertise. On some issues, representation from the lowest white-collar and blue-collar levels is sought. Those of high formal rank exercise only modest power in this decision-making process, since autonomy is critical to the group's success. For the senior executive, "Coordination... consists in assigning the appropriate talent to committees, intervening on occasion to force a decision, and, as the case may be, announcing the decision or carrying it as information for a yet further decision by a yet higher committee." (1978:66).

The declining authority that accompanies the approach of the highest rungs of the promotional ladder is documented by Burns:

> To be an older man in an industrial concern used to mean that one was more effective and better qualified... But in the new situation of technical and commercial change, the whole structure of authority implicit in this arrangement is becoming invalidated. It is not merely that chief executives, and even heads of industrial laboratories, confess in interviews that they find it difficult or impossible to grasp vocabulary, or meaning, or implications of the technical information and skills which their juniors possess, and for the sake of which they have been recruited... (1974:164).

Decentralization of workload is not identical with decentralization of administrative power (Fesler 1968). Movement of the work load to geographically or functionally subordinate units may not provide an opportunity for local authorities to exert substantial decision-making power. Fesler notes that where work is standardized, "the criteria to guide local decision-making are prescribed so precisely and comprehensively that field officials can only perform the clerical operation of matching the characteristics of each decisional case against detailed rule-book prescriptions." (1968:373). This observation is apposite in a public education setting where the quantity of school level decisions will rise as school-site[1] management practices are instituted. In Canada, significant structural change is seldom granted to public school principals since social and

---

[1] School-site management is a decision-making arrangement that substantially increases the ability of parents and school personnel to influence school policies. (Garms, Guthrie & Pierce 1978:178)

educational legislation, curriculum, student assessment, and planning and budgeting policies combine to tightly routinize their decisions. These effects are stronger during periods of inflation and reduced educational spending. School administrators may easily mistake the increased work load that accompanies a district initiative, nominally touted as school-site management, for an extension of their autonomy. In this circumstance, not only will Fesler's principle on decentralization of workload apply, but the school manager may also experience less independence because the decision rules are more explicit.

B. CAUSE AND EFFECT

Technology and society simultaneously influence each other as cause and effect. With computers, the interaction occurs across all social dimensions (Sheingold, Krane & Endreweit 1983:414). For the sake of simplifying the analysis of a complex relationship, most observers take either a cause or an effect stance on whether the form of computer technology determines the degree of organizational centralization. Some analysts, the sociologist Daniel Bell for example, have held both views, though at different times. In a 1973 work, Bell's position was that "by enlarging our control over nature, technology has transformed social relationships and our ways of looking at the world." (1973:188). Technology can resolve what he considered an axial problem of political systems, "the relation between the desire for

popular participation and bureaucracy." (1973:115). By 1979, however, Bell had retreated from his earlier commitment to technological determinism. He declared, "Technology does not determine social structure; it simply widens all possibilities." (1979:39). The affirmation that choice was still possible came at a time of mounting evidence which indicated a growing centralization of most government and commercial services. Amidst the debate over what would be the ultimate administrative effect of the new microprocessor technology, there emerged a challenge to the very existence of a causal relationship between microprocessors and centralization.

At least one observer, Simon, has denied the existence of a causal relationship between computers and centralization (Simon 1979:218). Simon claims that the effects of computerization can no longer be described in terms of either centralization or decentralization, because "what is occurring is a profound qualitative change in the decision-making process, which is being formalized, made explicit, and subjected to deliberate planning" (1979:222). He does not make clear how these components fundamentally differ from those which lead to centralization. Formalization of decision-making coupled with a strong planning element is at the core of centralization, and usually is accompanied by improved organizational control. A direct connection between technology and centralization, however, is difficult to demonstrate; verification depends on the calibre of

existing research.

There are few detailed case-studies on the relationship between computerization and centralization. Commonly, explanations are proposed and conclusions reached on sparse evidence (Mowshowitz 1976). This support often comprises general statements about contemporary events, and references to earlier reports which on close scrutiny lack substantiation. Where empirical studies into the organizational phenonomenon have been mounted, the research methods are frequently discounted for their lack of rigor. In 1976, Mowshowitz summarized the calibre of research, "The measures developed thus far tend to be crude and do not adequately discriminate between the effects of computers and other characteristics of organizational change." (1976:81). A decade of research has not rectified this situation. In 1985, Gotlieb observed, "The difficulty in assigning numerical values means that quantitative studies of the centralization/decentralization issue are rare." (1985:86). Despite the methodological problems that have been only partly resolved, the relationship between computerization and centralization continues to attract the attention of sociologists and other students of organization.

A major stride in the field was achieved by Kochen and Deutsch with their 1980 study of decentralization. Using an operations research methodology, in which mathematical models are devised for complex problems concerning the best allocation of available resources, they unified much of the

research into a theoretical framework that may serve as a foundation for further investigation. Formulae are provided from which to calculate optimal levels of decentralization for public service organizations. The degree of precision and the inclusion of considerable detail mark the study as exceptional.

The first objective of the research into the administrative use of computers in the B.C. public school system is to determine if sufficient means exist to calculate computer optimality. Closely associated with use is the adequacy of the provincial EDP design. The research question:

What are the cost-benefits of computer systems?

The quest for a methodology that provides a definitive calculation of optimality is tempered with the knowledge that constants are elusive when the technology is in flux. Today's certainties may be tomorrow's dinosaurs. Gotlieb (1985:86) offers a recent evaluation of this problem:

> Although the subject can be explored, it is not possible so far to apply cost-benefit comparisons in a way that will allow one to conclude exactly what balance between centralized and decentralized systems will achieve the optimum results in a particular situation. The difficulties are compounded because whatever cost estimates can be made are subject to continous revision due to the rapid rate of technological developments in the computer and communications industries." (author's emphasis).

The current debate over whether administrative users should purchase either the largest mainframe which they can afford, or the smallest computers consistent with departmental needs and join them together in a network (Economist 1985),

illustrates the uncertainty.

C. COMPUTERS AND CENTRALIZATION

Shortly after computers were applied to public and business administration in the 1950's, organizational theorists began to speculate on whether their effects would lead to greater or lesser centralization. Those who predicted increased centralization (Laubach & Thompson 1955; Slater 1958; Leavitt & Whisler 1958; Simon 1965; Lasswell 1971) focused on the enhanced control of information which a computer furnished. Applying Francis Bacon's well-tried dictum, "knowledge is power" (1825:219) to the new computing phenomenon, these analysts predicted that increased power will accrue to those who control the machine. Events of the 1960's appear to confirm their forecast. Increasing centralization during that decade evoked a new maxim, "Shared data means shared power; a monopoly of data means a monopoly of power." (Lasswell 1971:197).

The technical limitations inherent to the 1960's generation of computers meant that there was no practical alternative to centralization during the early years. Computers were expensive; their application was therefore confined to head offices where electronic data processing departments became closely linked with senior management (Slater 1958:166). Only a few observers at that time foresaw the possibility of decentralizing effects.

Lasswell was among the earliest to conceive not only the possibility, but the importance of assuring the decentralization of computing facilities. Although discussed in a political context, his insights have a direct bearing on public administration. He ascertains "that a vast system of documentation that relies on automatic methods is almost certain to possess built-in biases that affect public policy in the direction of centralization..." (1971:195). This bias is not necessarily detrimental. Effective use of telecommunications by global agencies can help to supplant parochial nationalisms with a democratic universalism. There is a continuing danger, however, that control might slip into the hands of a totalitarian regime, leading to monopolism and regimentation. Lasswell believed that this outcome can be avoided if laws are enacted to ensure broad popular access to data and the computer-based simulations with which data are analyzed.

Formal guarantees of access are not achieved without agitation, "if the many pluralistic elements in modern industrial nations seize promptly on modern methods of documentation, it will be possible to sustain political initiatives in the decision process of sufficient intensity to support a public order in which power is genuinely shared." (1971:197). Lasswell never satisfactorily resolved a contradiction between two of his basic premises. On one hand, he asserts that the power of telecommunications media should be directed to overcome national retrogression, on the

other, the emergence of totalitarian control would be prevented by investing numerous stakeholders with a direct influence in the new communications systems. Inevitably, one of the foremost stakeholders is the nation state. The question then should be asked, how can a global outlook be achieved without an international authority compelling nations to surrender some of their jurisdictional rights? To expect compliance by virtue of reason alone is to be unrealistically optimistic about the conduct of international relations. However democratic the intent, a barely distinguishable line may exist between compulsion and the practice of oligarchical realpolitik. As Meek warns, "a system geared to centralized control – even for the purest motives, to protect security and privacy and the liberty of the individual – is likely to be tailor-made for an autocratic or totalitarian regime. (Those who comfort themselves with the thought 'it can't happen here' should look at the places where it has happened.)" [sic] (1984:220).[2] This conflict, which may be better understood in a philosophical rather than an operations research context, is implicit in nearly every assessment of the social impact of informatics.

---

[2] The events surrounding Friday, October 16, 1970 provide an illustration. Robert Fulford, editor of *Saturday Night*, chronicled those troubled times, "In Montreal that first terrible week of the War Measures Act, hundreds of Canadians were arbitrarily denied their rights – their right to liberty, their right to counsel, their right to know why they were being held in jail, their right to communicate with relatives and friends. They were stripped, by an order of the federal cabinet, of all personal rights that hundreds of years of history had bestowed on them." (1970:11).

On a lesser scale, the internal rivalry between an organization's head office and its regional divisions parallels the political conflict between universalism and nationalism. The rivalry is consummately one of centralization versus decentralization: of head office control waged against regional autonomy. On an organizational stage, informatics provides an administrative means of resolving the dispute. Who controls the implementation of informatics and how it will be used to shape the structure of the organization are key questions that may be applied to a host of administrative matters. Perhaps Lasswell's most significant insight, in this regard, is that nonquantitative issues residing in the philosophical and political realms may be of greater social consequence than the cost-efficiency concerns of operations research.[3] This view is shared by Kochen and Deutsch who stress that "The content of political decision making is critically dependent on what the decision maker values." (1980:4). Few administrative decisions do not include a political dimension.

Microelectronics has revolutionary implications for society (Bylinsky 1981; Perlowski 1981; Ableson & Hammond 1981; Serafini & Andrieu 1981). Since 1945, computer generations have superceded one another with increasing rapidity: valve, transistor, integrated circuit, large-scale

---

[3] Gordon B. Thompson notes that "...the 'basic truths' of economics change throughout time. The real sources of wealth are precisely those activities that we perceive as being worthwhile, particularly where some labour gain can be incorporated. Were it otherwise, we would organize to change things." (*Memo From Mercury*. 1979:27).

integrated circuit, very large-scale integrated circuit, and now fifth generation[4] (Braemer 1984:148). Overall, the application rate of integrated circuits has been faster than for all previous technologies (ILO 1985:148). Individual organizations, however, have varied in the speed of adoption. Public school systems, as with the adoption of older technologies have been relatively slow (Oettinger 1969; Boyer 1983:186).

Different informatic effects may be noted in separate organizations. The combined result of microelectronics, however, is unpredictable in many areas of application (ILO 1985:7). Two aspects of these multifaceted informatics trends are discussed in the following two sections: 1.) the increasing dominance of administrators and professionals in the organization, and 2.) the relationship between computer programing hierarchies and organizational hierarchy.

1. Informatics and Administration

In 1967, Wilensky predicted, "The gulf between top executives and the information technologists... and men whose work is more programmed... will widen." (1971:282). Subsequent events in Canada (Sterling 1985:396) and other technologically advanced countries substantiate his

[4] Fifth generation characteristics include: 1) multiple instruction datastream, 2) does not need to know how many computers are in the system, 3) can double in performance, if the number of computers is doubled, 4) automatically rejects any failing computer, yet continues to work, 5) combines 'artificial intelligence' with parallelism (Parkinson 1985:765).

prognosis. Menzies finds that large employment sectors which comprise clerical and junior administrative positions in Canada's service industries are increasingly isolated from management. There is "a widening skills gap between what is considered clerical and what is considered professional work." (Menzies 1981:39). She reports ongoing "standardization, fragmentation and separation of occupational and job functions." that have followed in the wake of informatics (1981:38). The traditional job mobility which held the possibility of promotion for clerks and secretaries is supplanted by complete occupational discontinuity. Word processor operators and data entry/retrieval personnel are often confined to workstations where their day is closely organized and their productivity constantly monitored. Social isolation from the organization accompanies this confinement. An alert individual in the pre-microprocessor period could amass a large and often unique store of tacit knowledge about the organization, derived from handling correspondence and conversations with managers. An intensively networked and programed employment environment offers few opportunities to accumulate this knowledge (1981).

In the head office of an insurance company, which for Menzies typifies national trends, between six and eight word processor operators in two workstations took care of all but two of the two hundred member professional and managerial group. The two senior management exclusions were the only administrators to retain personal secretaries (1981:38).

The word processor operators work in isolated cubicles. There are no higher positions to which they may aspire. Adopting Harrington's view: in the advanced capitalist societies of late twentieth century they are, like the poor and chronically unemployed, on their way to becoming "superfluous people" (1984:123).

The same shifts in organizational structure occur in Europe where the International Labour Organization records that as the effects of microelectronics are experienced, "Intermediate-grade jobs vanish, and the work becomes more and more clearly divided between 'executive' functions and routine subordinate operations." [sic] (ILO 1985:41). Despite mounting international evidence that indicates a clear causal relationship between computerization and centralization,'some sociologists cling to the belief expressed by Horowitz, "It is dangerous to conceive of postindustrial technology as necessarily feeding the fires of administrative domination." (1984:124). Here, Horowitz challenges those who conclude that choice no longer can be exercised, that events of recent decades are manifestations of an inevitable movement toward global integration where informatics monitors and mediates the activities of all organizations: governmental, non-governmental, and commercial.

The study's second objective is to describe the impact of computers on administrators. The research question:

What is the impact of computers on managerial work?

2. The Relationship Between Organizational and Computer Programing Hierarchies

Simon argues that the structure of computer programs reinforces the hierarchical composition of those organizations in which computers function (1965:101). This effect is believed to arise from the sequential method in which computers process instructions. A program is a set of statements divided into routines and subroutines each of which, in a computer designed according to von Neumann principles, is processed in linear sequence[5] (Conrad 1985:465). The need to input certain types of information at specific points in the program is supposed to induce more rigid sequencing of information in the organization. This proposition derives from the assumption that information to which a typical organization responds is for the most part routine; therefore, content can be anticipated and methods devised to guide decision-makers.

Some of the most important types of information confronting an organization, however, is of an exceptional nature. As Minsky recognizes, there is "disparity between the explicit bureaucratic regulations that are supposed to handle situations in general and the inevitable bugs and problems such systems cannot deal with." (1979:415). Reference to existing policy is of little help in formulating

[5] Contrast the lock-step nature of linear processing with the multiple instruction datastream found in parallel and fifth generation computers (Parkinson 1985:766). When parallel processing becomes commonplace, sociologists may visualize the typical human organization as a parallel processer.

responses to the non-routine. Although computer programs usually reject data for which they were not specifically designed, an organization's survival may depend upon the capacity of its members to recognize the significance of the singular and rapidly respond.

The claim that there is a connection between an organization's decision-making routines and the structure of those governing a computer seems to have been abandoned. An explanation for the relationship between programing and increasing organizational hierarchy may be traced to the analytical procedure that accompanies the writing of a program. Rules governing work procedures become better understood during the systems analysis[6] that precedes the program, and this analysis leads to formalization of work routines. Senior management derives improved means of control from the formalization process. Despite the tendency of computers to have an overwhelming centralist impact on organizations, the possibility that with careful design they might equally sustain a decentralized organizational structure has received renewed attention.

D. DECENTRALIZATION AND THE NEW TECHNOLOGY

Whether computerization can foster decentralization has received renewed attention by many analysts (Bell 1979; Simon 1979; Nora & Minc 1980; Kochen & Deutsch 1980;

[6] Systems analysis is the analysis of the role of a proposed system and the identification of a set of requirements that the system should meet, and thus the starting point for system design (Illingworth 1983:358).

Frantzich 1982; de Sola Pool 1983; Brooke 1984). Generally, this group rejects the hypothesis that an autonomous force, technological determinism, produces centralization; instead, they hold that organizational impact results from the way the machine is used. Three main arguments forwarded by decentralists are that: (1) decentralization *ipso facto* is desirable, (2) some forms of microelectronics, for instance personal computers, provide an alternative to centralization, and (3) marketplace competition offers the organizational consumer significant technological choice.

1. Ambiguity of Computer-Based Decentralist Position

There is a large degree of ambiguity present in the argument for decentralized control. Completely independent use of this technology by a subunit at any organizational level grants that unit improved control over its immediate environment, thereby leading to increased centralization at that level (Brooke 1984:147). Observations by Frantzich provide a recent example of the ambiguity (1982). In the opening chapter of his study on the use of computers in the Congress of the United States of America, Frantzich states, "Whoever controls the creation and dissemination of information can control its content and impact. To the degree that Congress is dependent on others for its information, Congress loses its role as a free participant in the decision-making process" (1982:35). Control of computers is equated with Congressional autonomy. Yet in summarizing his

findings, Frantzich seems reluctant to concede that a similar computer-based information dependency is found at an intra-organizational level among Congressional members.

An hypothesis derived from increased Congressional dependence on computer-based information might reasonably predict a narrowing of the members' voting behaviour, which thereby restricts the breadth of new legislative initiatives. For Franzich, proof of centralizing forces that result from computer use, although self-evident in the dealings of Congress with other agencies and levels of government, remains insufficient in the internal operations of Congress. (1982:250). There is an arbitrary limit to the autonomy which decentralists are prepared to grant.

2. Microcomputer Autonomy Absorbed by Networks

The appearance of microcomputers seemed for a while to lend substance to the decentralist claim that ownership of appropriate technology would assure autonomy. The use of personal computers was expected to lead to increased autonomy for organizational units such as schools. The first commercial production of a minicomputer by Digital Equipment Corporation in 1963 (Vacroux 1975:32), contributed to the further decline of data processing costs which continued to the present. Similarly, the initial manufacture of a microcomputer in 1971 (1975:36) leant even greater impetus to reductions in hardware costs. Departments and divisions sited at locations remote from their head offices could, for

the first time, afford the comparatively low cost of stand-alone equipment.

The diffusion of computer technology to the organizational periphery was not accompanied by a transfer of power. On the contrary, senior executives utilized informatics to consolidate their control (Scannell 1981). Until approximately 1982, corporate command over personal computers was virtually non-existent (Pantages 1985:24). Following 1982, the directors of corporate Management Information Systems (MIS)[7] became involved in decisions to acquire personal computers, and they now control any plans to connect the machines to mainframes. Their influence accelerates hardware and software standardization (Gotlieb 1985:101). The decentralizing potential of microcomputer acquisition at the lowest organizational levels is offset by the increased processing capacity of central office mainframes. As a 1981 Fortune survey showed, companies which switch from centralized to distributed data processing often do so to maintain centralized control over remote branches operating as profit centres (Scannell 1981:10). Throughout the early 1980's all aspects of work have been evermore tightly integrated through the medium of these machines (Menzies 1981; Perrow

[7] Management Information System: "An information system whose prime purpose is to supply information to management. The initial concept of MIS, commonplace in the 1960's and early 1970's, was that systems analysts would determine the information requirements of individual managers in an organization, and would design systems to supply that information routinely and/or on demand. *Decision support systems* form a new class of MIS, giving much greater independence in their use of computer-based information." (Illingworth 1983:215).

1984; ILO 1985).

Where microcomputers appear, computer networks soon follow. Local area networks (LAN)[8] frequently relegate microcomputers to the status of workstations capable of some stand-alone processing. Extending computer networks to encompass all administrative facets continues in most public and business organizations. This development is reflected in the current International Business Machines Corporation (IBM) marketing strategy in which the proliferation of smaller computers is expected to raise the demand for mainframes (Economist 1985:68). During recent years, IBM has promoted the expansion of local area networks and, as was the case with personal computers, supported their inclusion within the MIS department's sphere of influence. IBM has also extended its corporate domain to include a global satellite communication system (Borrus & Zysman 1985:188), the linchpin of a wholly integrated and privately owned worldwide telecommunications network. This recent event leant further confirmation to a 1983 study for Communications Canada which contends that IBM is "undergoing a metamorphic change from being a manufacturer to being a vast, immensely sophisticated processing and communications solution-oriented network." (1983:91). Privately owned

---

[8] Local area network: "A communication network linking a number of stations in the same 'local' area, variously defined as the same building, a radius of one kilometer, or a single plant. Local area networks generally provide high-speed (100K bps to 100M bps) data communication services to directly connected computers." (Illingworth 1983:203).

international systems are considered by some critics of a decentralist persuasion to be the antithesis of democratic control (de Sola Pool 1983).

A strong distinction is drawn by de Sola Pool between microcomputer use, and the ownership of national and international telecommunication networks. "Freedom is fostered," he writes, "when the means of communication are dispersed, decentralized, and easily available, as are printing presses or microcomputers. Central control is more likely when the means of communication are concentrated, monopolized, and scarce, as are great networks." (1983:5). Although the association of personal computers with autonomy may have been a reasonable expectation during the early 1980's, market developments have already shifted them toward control within a centralized electronic data processing environment. In no small measure, this move results from the influence of leading computer manufacturers that make organizational integration of personal computers part of their marketing strategy.

3. The Market as a Determinant of Organizational Impact

The market is proposed as a mechanism for regulating the ultimate social effects of computerization. Those who hold this view summon the market as a catalyst for translating technological advances directly into public and commercial benefit. The numerous multivariate, interrelated and, at times, contradictory forces which drive the activities of

original equipment manufacturers and constrain the activities of their corporate clients (Fishman 1981; Fisher, McKie & Mancke 1983) play little part in this idealized model. According to the laissez faire paradigm, buyers are free to choose. Consumer exercise of choice generates new product designs. In support of this claim, de Sola Pool states, "Today, in an era of advanced (and still advancing) electronic theory, it has become possible to build virtually any kind of communication device that one might wish, though at a price. The market, not technology, sets most limits." [sic] (1983:6).[9] The connection between computerization and centralization is reduced to a matter of financial expediency; quite simply, "any change in technology that makes it cheaper and easier either to centralize or decentralize decisions will tip the balance in that direction." (Simon 1979:216). Cost-efficiency in Simon's view outweighs all other considerations. If an enterprise can afford to purchase a specific product, then this action is taken irrespective of outcome. Fluctuations in the intensity of centralization are explained as responses to shifts in the affordability of new technology.

The simplified marketplace model advanced by de Sola Pool and Simon does not begin to approximate the complex

[9] Addressing the role of the market as a determinant of quality in United States television programing, Goodlad writes, "As for this society, television may be... the nearest thing we have to a common school. But in pondering the fare offered and the sums of money invested in providing it, one easily becomes despondent. Free competition among the major networks has not provided much to enlighten the mind or free the human spirit." (1983:342).

nature of informatics sales within the western economies. In these planned economies (Burns 1974; Galbraith 1978:402; Walker 1984:100), the informatics market is dominated by a small number of multinational corporations (Archbold & Verity 1985:36). Their predominance allows them to plan for product cycles lasting at least five years beyond the research and development period. With few exceptions, product design results solely from choices made by equipment manufacturers. The public and most commercial users exercise only an indirect and relatively modest influence in the design process. As with all great firms, these corporations "establish prices and seek to ensure a demand for what they have to sell." (Galbraith 1978:33). The overwhelming capacity to influence the informatics market is manifest in the leader, International Business Machines Corporation.

The extent of IBM's influence is indicated by its 1984 fiscal performance. IBM's total 1984 data processing revenues of 44.29 billion dollars represents thirty-three percent of the 132 billion-dollar revenue generated by the non-communist world's leading data processing manufacturers (Archbold 1985:58). IBM has **seventy-five percent of the market for mainframe computers and mass-storage disc drives** (Economist 1985:58) – a near world monopoly since, with this overwhelming share, competing companies are forced to follow IBM specifications (Fisher et al 1981:58). Mainframe sales alone reached twelve billion dollars in 1984, accounting for one-half of IBM's net 6.6 billion-dollar earnings (Economist

1985:65). These sales place it at the top of all corporations with head offices in the United States. Research and development costs typically run at between nine and ten percent of revenue (1985:66).[10] Revenue, of course, is only a rough measure of influence, a corporation's history and current structure provide a better composite of its influence.

Computers and IBM have grown together. In the popular imagination, as well as the reports of analysts who specialize in the business of informatics, often the two appear inseparable. IBM and contemporary national governments have grown together, leading Foster to declare, "The complex and intrusive nature of the modern state would be no more possible without computers than would a flight to the moon." (1984:28). Behind IBM stands a corps of 400,000 employees, including sales personnel, planners, engineers and scientists.[11] The Corporation maintains close relations with senior politicians and executives around the world. Previous IBM employees with distinguished company records occupy important MIS posts throughout higher education, government and industry. The personal relations network consisting of contacts in education, business and government, is a force without equal. Finally, corporate data banks containing detailed information on the governments and institutions with which IBM deals permit considerable scope

[10] "In 1981, IBM spent $1.612 billion on R&D. Out of every R&D dollar spent by the American computer industry, IBM accounted for about forty cents." (Department Of Communications 1982b:82).

[11] 11,000 employees in Canada (Foster 1984:22).

to the planning process.[12] IBM's control of the informatics market has seldom been stronger. Foster predicts that within the decade, IBM, or IBM compatible machines, will hold ninety-five percent of the world market for mainframes (1984:27).

Even the few corporate characteristics surveyed in this sketch have been glossed over by those who suppose significant choices are permitted the organizational purchaser of computer products. Inevitably, lead times involving research and development, and the considerable sums expended in bringing new microelectronic products on stream, compel major informatics companies to plan carefully and ensure a virtually captive market for their goods.[13] Apart from a few research institutions, and some large multinational corporations specializing in non-computer production, the parameters of choice are determined by the seller. The very success of corporate marketing strategies in assuring demand may have led to what some critics posit as an overly favourable view of computer economics.

---

[12] Serafini and Andrieu (1981:28) comment, "They (multinational informatics corporations) have also been able on occasion to take advantage of weak international agreements and international rivalries between countries to evade national legislation and pursue independent policies, sometimes in conflict with the interests of the host countries. The role of these firms is particularly important in Canada where a large number of multinational branches exist as a result of heavy foreign investment over many years."

[13] Barna (1985:19) implores, "Waiting another four years before reexamining IBM's market power may be too late. The bill that is rendered may well be tallied in terms of technologies not developed because prudent business people found the prospect of competing with IBM too daunting."

On an applied level, the cost of performing office work with computers frequently increases, compared with the cost of older, non-computer routines. King cautions that for local governments "Early adoption of advanced applications of information technology is often uneconomical in cost-benefit terms." (1982:25). Frantzich warns that while computers are "...touted as a method of saving money, in the long run, computerization involves dramatic personnel and start-up costs, which are followed in quick order by updating costs." (1982:57). Further confirmation in a public service setting comes from Ayers and Kettinger, who find "little evidence... that the introduction of computers has actually reduced costs in government." (1983:565). While labour productivity can often be shown to have risen, factor productivity – where unit outputs are compared with all input costs including labour, capital, energy and facilities – have climbed in most public service organizations. Frequent claims by senior management that an office computerization project is cost-efficient, may upon close scrutiny, prove false. Lack of detailed financial information in the public domain prevents a thorough evaluation of computer derived cost-benefits. Even if the performance of established clerical routines by computers is of marginal cost-benefit, their capacity to perform new types of analysis will likely justify their cost. These new applications frequently lead to increased control.

The study's third research objective is to observe whether computerization is leading to increased centralization. The research question:

> Is computerization associated with centralization in organizations?

E. PLANNING, PROGRAMING, AND BUDGETING SYSTEMS

A form of analysis that the British Columbia Ministry of Education finds attractive in achieving improved financial control within the public school organization is that offered by the Planning, Programing, and Budgeting System (PPBS).[14] The Ministry introduced their version of PPBS in fiscal year 1983-84 to manage school district financing. The five-year school district computer acquisition program, begun in 1982, met the increased data processing demands of the Ministry's new program, budgeting and accounting system. Hence, in the context of the B.C. public school system, an assessment of the implications of administrative computerization would be incomplete without a discussion of the theory and practice of the Planning, Programing and Budgeting System.

Conceptually, PPBS is a totally integrated process that extends from the planning and analysis functions through programing and budgeting into operations, reporting and control. PPBS depends heavily on computers (Novick 1973:30;

[14] PPBS is also known as "PPBES, where the 'E' stands for Evaluation; EPPBS where the 'E' represents Education; ERMS or Educational Resource Management System; and the Resource Allocation Decision System RADS," among other designations. (Knezevich 1981:2).

Brackett et al 1983:44) and is centralizing in its organizational effects (Hirsch 1967:205; Wildavsky 1969:192, 1975: 328). Expectations that PPBS will result in increased centralization are supported by Gross and Mosher in separate assessments. Gross observes that PPBS budgeting reforms are necessitated "whenever increasing centralization outruns the capabilities of the central guidance cluster." (1969:113). Mosher notes that "Like most other budgeting reforms, its basic effect – perhaps its basic though seldom-stated purpose – is toward centralization of power..." (1969:164). While there are competing theories about whether computerization leads ultimately to centralization or decentralization, no similar debate frequents the PPBS literature. The possibility of a decentralizing outcome does not seem ever to have been seriously considered.

Beyond the central principle of rationality in choosing between alternate courses of action, Steiner lists three important distinguishing features of program budgeting: structural, analytical and informational (1967:310). First, the structure of PPBS is end-product oriented; objectives are functional and include all cost elements associated with their attainment. While short-range decisions continue to be made, emphasis is placed on the long-range perspective. Second, the analytical process compares alternate courses of action, and leads to an assessment of their implications. The process has various names, including cost-benefit analysis, cost-effectiveness analysis, systems analysis, and

operations research (1967:311). At this stage, all major costs and benefits are compared. The third element is the information system which is closely integrated with the first two functions. It not only aids in the specification of possible objectives, but also tracks all pertinent costs attached to existing programs. The information system provides a method of controlling expenditures and reporting administrative progress.

Some policy analysts (Royal Commission On Financial Management And Accountability 1979; Crozier 1980) claim that present public administration budgeting and accounting policies are labyrinthine,[15] and therefore overdue for reform. Other analysts (Lindblom 1968; Wildavsky 1975, 1979), while not denying the serious administrative problems that have arisen, counter that this complexity accurately reflects our late Twentieth Century knowledge of the world, and that incremental budgeting wins support for government policies where the only alternative is crippling division and administrative secrecy. Issuing a challenge to complex administrative practices, Crozier contends, "Behind the American PPBS, the French RCB, and various other versions of the same techniques throughout the world, one does not have to look very far to find a deep-seated and perfectly justified desire to reform a machine so weighed down by the complexity

[15] The Commission found that the, "hodge-podge of accounting methods used in assembling the financial statements of the Government of Canada... defeats the... principle purposes for which financial information about governments, and other non-commercial organizations is required." (1979:247)

of mutual adjustment that it is impossible to run." (1980: 172). This argument is countered by Wildavsky who maintains that the attribute of complexity, that is, "The incremental, fragmented, nonprogrammatic, and sequential procedures of the present budgetary process help to win agreement and reduce the burden of calculation." (1975:329).

When performed properly the practice of PPBS is an expensive undertaking. Since its introduction is usually spurred by a legislative preoccupation with dwindling finances, there are insufficient resources available to ensure success. At least two authorities, Lee and Johnson (1983) believe that the the implementation of PPBS is beyond the financial resources of most governments, no matter their solvency. They find that in virtually all cases "the capability of public administration to meet the complete requirements of systems analysis is non-existent. The costs of information are so high as to make it rational to be ignorant, to make decisions on the basis of limited search behaviours and limited information." (1983:16).[16]

---

[16] The issue is complicated by Larkey's and Smith's finding (1984:80) that budget officials and, "Chief executives misrepresent more than their public formulations of the budget problem. They also misrepresent the reasons for the formulations. In the public justifications of their budget formulations, chief executives follow a dominant explanatory strategy: *they explain their budget formulations in ways that absolve them of most responsibility* (authors' emphasis). Their basic tactic is to portray the budget as largely due to factors beyond their control. Explanations emphasize bad news above all else... Any good news presented is qualified by the bad..." (see also D. Gerwin, Budgeting Public Funds: The Decision Process In An Urban School District. University of Wisconsin Press, 1969).

The remaining discussion focuses on the public service experience of PPBS by three governments: the United States of America, Canada, and British Columbia. The discussion begins with a general examination of PPBS in public education and ends with a summary of the 1983 introduction of a PPBS-derived financial and budgeting reform within the British Columbia public school organization.

1. Role in Public Education

Educational administrators have turned to PPBS with the expectation that this budgeting system will assist them in choosing more efficient and effective policies (van Geel 1973:1). However, education, unlike aircraft production (where PPBS was first applied), is not transparent to policy-oriented analysis (Garms & Guthrie 1978:255; Lee & Johnson 1983:104; Saunders & Klau 1985:124). There are many questions which may confound the circumspect educational planner. Some of these are outlined by Hirsch:

> What knowledge and skills should be developed; when, where, how, and by whom and for whom? ...in a given year, what kind of education should be offered for how many students, by how many teachers (and support personnel), with what background and training, and in what facilities? In addition, there is the issue of who should pay for the education. [sic] (1967: 181).

The simplicity and directness of these questions have a universal appeal; they concern parents, politicians, philosophers and educational specialists alike. The unwary may seek facile answers where two millenia of our best minds have perceived a challenge without end.

Fundamental questions are usually neglected in administrative debates about budget allocation. When program budgeting is applied to educational policy, the administrator typically commits the organization to an *a priori* mode of reasoning in which policies arising from these questions are assumed to be susceptible to rational analysis. In this context, the teaching of reading provides a good demonstration of a PPBS application.

Reading is a subject which some educational budgeters consider adaptable to a process model. Set aside the perennial debate about whether any single reading education method is a statistically significant improvement over the rest.[17] Assume that for an additional expenditure of one hundred dollars per pupil, reading scores will improve by a known amount. The PPBS process model operationally reduces the reading policy to a formula where more dollars, or input, is translated into better pedagogical techniques, or improved throughput, finally producing higher reading scores, or enhanced output. To achieve advances in reading performance, funds must either be diverted from other educational programs or be obtained from outside the organization. The second alternative requires that costs of other government services, such as health and defense, be

---

[17] Otto, Wolf & Eldridge (1984:799) in a perceptive review of major reading methods find that as for results there is is little to distinguish them, "Now, with some of the major historical trends identified, consider again the question of how best to organize students and teachers for the effective teaching of reading. The question has an easy answer: put one student and one teacher together and let teaching proceed through one-to-one tutoring."

accounted for by the same financial system, since to function according to PPBS principles, comparisons can be drawn only with those programs already operating within a process model. To compare educational costs with government service costs arrived at through other accounting methods is to plunge into an arbitrary world of muddling through, where policy justification is sought *a posteriori* (Lindblom 1959).[18] The topic of financial reform as it relates to reading education is one that will be resumed later in the context of the United States.

a. The United States of America

PPBS emerged from an industrial planning and accounting model which the United States of America applied successfully to aircraft production in the Second World War. During post-war reconstruction, Ford Motor Company refined the model to automobile manufacture (Halberstam 1969:229). Following ten years of preparatory work by the Rand Corporation, PPBS was first introduced to public administration in 1961 for use in the United States Department of Defense (Schultze 1968:1). Four years later, President Lyndon Johnson directed all federal departments and major civilian agencies to adopt PPBS along the lines of the Defense Model (Schultze 1968:1). These undertakings were relatively short-lived. The federal government, first to introduce program budgeting, was first to abandon it (Schick 1973: 147).

---

[18] Crozier's caustic retort, "The *a posteriori* rationality is a static rationality of vicious circles." (1980:172).

In the summer of 1967, Budget Bureau officials reluctantly, but officially found "the longer term objectives of PPBS are now unclear to many."[19] By September of that year, William Gorham, former Assistant Secretary, Department of Health, Education and Welfare, and widely acknowledged to be an outstanding practitioner of program budgeting, testified on the problematic nature of achieving a consensus on program objectives for public education:

> But we want our children to be different sorts of people. We want them to be capable of different sorts of things. We have, in other words a plurality of opinions about what we want our schools to turn out. So you drop down a level and you talk about objectives in terms of educational attainment. Here you move in education from... fuzzy objectives, ...to more concrete, less controversial, more easily to get agreed upon objectives... [sic].[20]

Despite the satisficing[21] character of incremental budgeting, and the acknowledged difficulty of arriving at generally agreed upon program objectives, public education has achieved a surprising level of efficiency. Neither program budgeting nor similar cost-benefit fiscal processes fully capture the efficient nature of public education since what a student actually learns may be attributed more to personal, parental and community aspirations than to the

---

[19] U.S. Bureau of the Budget. The Work of the Steering Group on Evaluation of the Bureau of the Budget: A Staff Summary, July 1967, p. 2-11.

[20] Joint Economic Committee, Congress of the United States, Hearings, The Planning, Programming Budgeting System: Progress and Potentials, 90th Congress, First Session, September 1967, page 80 (quoted in Wildavsky 1969:195).

[21] "A variable relationship between aspiration and satisfaction, or, more specifically, a variable perception of opportunity costs involved." (Burns 1974:138). The term was coined by Simon (1958).

centrally mandated curriculum. Reflecting on the disjunctions which occur between the formally mandated organizational goals and those of the diverse publics which the American public school serves, Perrow concludes with gentle irony, "the system of education is quite efficient for accomplishing many things that many participants desire; they are just not what the school district or the federal government, which supplies the money, had in mind." (1984: 91).

The preoccupation of many federal, state and local educational administrators with financial and budgetary reform is a triumph of process over content. There is no evidence to show that these procedures have placed more teachers, more books and improved educational facilities in the nation's schools. On the contrary, resource cutbacks and reallocations often accompany fiscal reform (Hartle 1976:24). The constant attention demanded by continuing shifts in bureaucratic procedure saps the organization of energy that is more appropriately expended on improvements in educational services for students.

Internal financial reform apparently contributes little to winning the important political decisions that ensure improved educational opportunities for all – especially the children of the poor and disadvantaged. In the United States, these decisions have been lost to military lobbyists (Table I, page47). United States education received 137 billion dollars in 1980, fifteen billion dollars more

than the total spent on defense. Five years later the picture had changed. Defense spending in 1985 was 299 billion dollars, almost **one hundred and forty-six billion dollars** more than the total federal, state and local expenditure on public education (Table I).

An important output measure of the diminished United States support for public education is gauged from the rising level of illiteracy. The Adult Performance Level (APL), a study carried out at the University of Texas, placed United States illiteracy at thirty percent (Kozol 1985:9). After considering several sources on United States illiteracy, Kozol cautiously estimates the number of illiterates "in terms of U.S. print at the present time" at sixty million out of a total of two hundred and thirty-four million people (1985:10).[22] The rising number of illiterates coincides with either the reduction or termination of major social and educational programs. Coincidentally, the 1985 United States military expenditure was higher in constant dollars than in any year since 1946 (SIPRI 1985:242).

b. Canada

The Canadian public administration experience with PPBS follows a pattern similar to the United States. The federal government's first serious move in the direction of PPBS came in 1966 with the Treasury Board directive to all departments requesting submission of a five-year forecast on what

[22] UNESCO reports the 1979 U.S.A. illiteracy level at 0.5% for those fourteen years and older (UNESCO 1984, 1-18).

Table I
United States Expenditures
On Public Education And Defense: 1980-1985
(In Billions of Dollars)

Year	Public Education[1]	Defense[2]
1980	137.8	122.7
1981	149.5	142.7
1982	160.5	213.7
1983	172.2	239.4
1984[3]	152.2[4]	273.4
1985	153.8[4]	299.0

Notes:

[1] Preschool to Grade 12 – includes local, state and federal spending. Statistical Abstract Of The United States: 1985 (105th edition), U.S. Bureau Of The Census, 1984.

[2] The Military Balance. 1979-1980 to 1984-85 inclusive, International Institute For Strategic Studies.

[3] After a forty percent increase in military spending over the last four years, the Administration's plans are for a further forty percent rise in the next five fiscal – years up to fiscal year 1989. (SIPRI 1985:14).

[4] Projections of Educational Statistics To 1990-91, Volume I. National Centre For Educational Statistics, 1982.

each considered to be their programs (MacDonald 1973:78). There was considerable resistance to operational analysis. Summing up seven years of federal PPBS effort, MacDonald did not believe it possible to "cite a clearly documented instance where a decision to undertake program A rather than program B or C was arrived at on the basis of analysis alone..." (1973:77). The Royal Commission on Financial Management and Accountability, struck in 1976, to examine the accounting methods used by the federal government, in summation was more direct:

> Overall, the application of PPBS as the central budgetary tool has met with mixed success. The decision was made in 1970 to overlay the system with a new procedure requiring departments to submit budgets detailing both the level of existing programs (the "A" budget) and the costs required to improve the quality of service, to extend the programs, or to finance new program and new capital projects (the "B" budget). In practice, the use of two budgets enhanced the tendency in the budgetary process, carried over from the pre-PPBS system, to concentrate attention on requests for new funds, with the result that there is a more limited review of the "A" budget, if at all, and existing programs seldom come up for serious re-examination.
>
> Moreover, it has proved extremely difficult to establish more explicit objectives for programs, and to put in place within departments workable systems whereby the efficiency and effectiveness of the programs are measured. (1977:23).

This passage lends official Canadian credence to Wildavsky's unequivocal statement that "PPBS has failed everywhere and at all times." (1975:363).

c. British Columbia

Commencing in the late seventies, a major program of fiscal and budgetary reform was instituted by the British Columbia government. The province selected zero base budgeting (ZBB) as its reform model. ZBB which is an experiment to see if a PPBS-type mechanism will work (Wildavsky 1975:276), was introduced to the Ministries of Forests and the Attorney General in fiscal year 1979-80. By the 1981-82 budget cycle, ZBB was implemented in all but four ministries – Education was one of the exceptions (Ritter & Cutt 1985: 45). In its original form, ZBB requires that budgeters start from a zero base; expenditures within each program are justified at the beginning of the budget cycle. The provincial government's practice of Zero Base Budgeting carried significant additional costs resulting from extra preparation time required to meet the new stipulations (Ruff 1983:192). When a ministry actually met the stipulations, Treasury Board could not conduct a complete review:

> The Treasury Board did not have the capacity to utilize all the information generated by ZBB. The decision-making process was not being served by the introduction of excessive detail.
> (Ritter & Cutt 1985:47)

Costs related to negotiation are viewed by Lee and Johnson (1983:73) as wasting "valuable administrative time by requiring the rehashing of old issues that had already been resolved." These costs soon forced the replacement of the zero base with an operational minimum – an amount below

which the budgetary allocation would not fall. The concept of an operational minimum restored the old incrementalist maxim, where what is spent this year is the best measure of what will be spent in the next.

In fiscal year 1983-84, the British Columbia Ministry of Education replaced a long-established school district line item accounting and budgeting procedure with a new Program, Budgeting, and Accounting System. Although seldom referred to as PPBS by Ministry officials, the outline in Figure I (page51) demonstrates that all major elements are incorporated in the Ministry's model. The genealogy of this budgetary reform is explicit in the following excerpt from the Ministry's Program Accounting and Budgeting Manual:

> The development and implementation of a full planning, programming, budgeting and evaluation system is at the discretion of each school district. However, the introduction of a program accounting and budgeting system on a uniform basis across the province is the initial, and very valuable step in developing a more comprehensive district planning system. (1983c:1.5)

This statement implies that the Ministry's reform model is incomplete; however, the definition of what constitutes a 'full' PPBS system remains moot. Neither a public service, nor an educational administration has succeeded in introducing a pure PPBS model – one in which every output is operationally related to a resource input. Educational administrators usually are satisfied with identifying a relatively small number of output measures. For the B.C. Ministry of Education, these measures appear to be class size and the cost of delivering each of the programs within the nine

Figure I
Major Components Of The Program Accounting
And Budgeting System – Fiscal Year 1983-84
British Columbia Ministry Of Education[1]

---

1. Information
   - -reports finances and operations
   - -fewer forms filled less frequently

2. Fiscal Framework
   - -sets the amount required to provide a basic educational service in each school district
   - -province establishes service levels (standards) and cost factors
   - -return to 1975-76 service levels by 1985-86

   (a) Function:
   - -a group of related programs representing the highest level of educational activities
   - -total of nine functions in 1984

   (b) Program:
   - -a set of related activities, including statements describing content, objects and resources

3. Budgeting
   - -boards project revenues and expenditures by educational activities
   - -financial expression of objectives, programs and activities of the public school system
   - -planning tool rather than a cost accounting exercise

4. Funding
   - -funding in the form of provincial grants will cover at least sixty and as much as ninety-five percent of approved budget

5. Accounting
   - -follows program budget structure to record expenditures and revenues

---

Sources:

[1] Fleming & Anderson (1984) and B.C. Ministry of Education Program Accounting and Budgeting Manual (1983c).

functions.[23]

Although few official Ministry statements relate student achievement directly to expenditure, there is a marked increase in the measurement of pupil performance. The Ministry introduced provincial grade twelve examinations and carried out the third provincial reading assessment for grades four, seven and ten in the 1983-84 school year (Jeroski, Tolsma & Labercane 1984). Grade twelve examination results contributed toward fifty percent of a student's graduating mark. The 1984 reading assessment was the first to provide school-level measurements (1984:2).

The provincial examinations replaced those set by local teachers at the school and school district level. Their primary aim is to "...encourage teaching to the curriculum and promote more effective and purposeful teaching." [sic] (Heinrich 1983:60). Thus an output measure gauges the degree to which teachers comply with the centrally mandated curriculum or analytical model.[24]

Testing fulfills an important role in the new educational process model. Assessment scores are made public, and local school boards are instructed to release examination results to their constituents. In the Minister's words:

With both Grade 12 exams and the reading assessment

---

[23] A major objective is to reduce public school expenditures and increase pupil/teacher ratios to 1975-76 levels by the 1985-86 fiscal year (Fleming & Anderson 1984:36).

[24] Anderson, one of the authors of the financial and budgeting system, extensively researched teacher productivity among inner-city schools in the southern United States.

> for Grades 4, 7 and 10, overall achievement levels for the province will be made public. District or individual school results will not be identified. These results will be forwarded to the district superintendent of schools. I shall expect boards of school trustees, in consultation with local educators, to review the data and provide the local taxpayer with a summary of student achievement in the district. (Heinrich 1983:60).

The Minister's clear affirmation of a connection between the resource base or 'local taxpayer' and the output or 'student achievement' reflects the very nature of the Ministry's new Program, Budgeting and Accounting System. Increasing school and school district administrative concern with aggregate class and school performance on these metrics supports the claim that output measures are being applied more extensively than is at first apparent from the Ministry's new accounting procedures.

How these output measures contribute to improved educational performance is not clear. Resources which could be directed to reducing class size and introducing expanded educational opportunities have been diverted to student assessments and financial monitoring. Assessments demonstrate what has long been known in British Columbia and elsewhere in North America: only significant increases in expenditure in the classroom will bring about improved learning among children. Reading is a salient example. Five years before the financial cutback and reform programs were instituted, the Ministry acknowledged that "Comprehensive, high quality reading programs are available on only a limited basis in the secondary schools of British Columbia

for a variety of reasons, including a shortage of trained personnel – a factor which should be amenable to treatment." (Ministry of Education 1977b:1). Rather than improve learning opportunities, the 1982 program of financial cutbacks resulted in higher student/teacher ratios and reduced or eliminated special educational programs for children who encounter difficulty learning English.

Whether the Ministry's PPBS-type budgeting reform will succeed where virtually all others have failed is debatable. Perhaps the Ministry of Education's greatest success, as with the provincial government's practice of Zero Base Budgeting, is to have "reinforced a restraint and efficiency mentality..." (Ruff 1983:192) within the public school organization.

2. PPBS Overview

PPBS is an accounting method which increases central control by maximizing the relationship between inputs and outputs. The system emerged in a commercial setting where it was profitably applied to automobile production. Following ten years of preparatory work by the Rand Corporation, program budgeting was introduced to the United States Department of Defense in 1961. This constituted the first application to public administration. By 1965, all United States' federal government departments and agencies were required to adopt PPBS. Despite considerable official commitment, only a few years passed before the United States

government abandoned program budgeting.

Canada's public administrators had a similar experience with PPBS. Two years after the federal Treasury Board introduced this system, incremental methods again prevailed. In British Columbia, Zero-Base Budgeting, a system with a comparable methodology, was introduced in 1979. Within two years, ZBB's guiding principle, that in each budget cycle, proponents justify all program expenditures beyond a zero base, was jettisoned in favour of incrementalism.

Most practitioners and independent researchers concur that PPBS is ill-suited to public administration. PPBS sacrifices political for operational rationality. The system is costly to institute and a shortage of skilled professionals compounds administrative acceptance. In public education, where schools must respond to a multiplicity of competing and not infrequently contradictory goals, PPBS is particularly problematic.

This leads to the fourth research question:

What is the relationship between organizational objectives and the design of computer systems?

F. SUMMARY OF THE LITERATURE REVIEW

Computers facilitate centralization. This relationship was clearer when there were fewer computers and they were installed only in head offices. Centralization effects remain strong and continue in spite of new influences, such as that of the microcomputer which offers significant computing power to low-level administrators. Long-term

planning strategies adopted by IBM partly explain the recent resurgence of centralizing technologies. The organization and administration of all aspects of society on a global scale, however, has proceeded unabated for several centuries. In recent decades, this process has accelerated. There are profound political and environmental reasons for administering the Earth and its peoples as a highly integrated set of interdependencies. Among educational organizations, computers are indispensible in the progress toward world management.

Closely allied with the inherent capacity of informatics to favour centralization is the issue of how this techology is applied to perform work. The largest administrative application of computers in the public education system of British Columbia was undertaken to meet the requirements of a new planning and budgeting system. Cost reductions and increased efficiency, the twin aims of this centralized financial system, are attained by linking financial inputs with educational outputs, then comparing the performance of administrative units.

III. METHODOLOGY

This study of the administrative impact of computers on the public school system drew on the analysis of interviews and documents. Interview disclosures were compared with each other, and with statements derived from published and unpublished reports. Although some quantitative data were integrated with this information, the methodology remained predominantly that which many contemporary organizational theorists refer to as qualitative research (Van Maanen 1983).

During the past decade, the term qualitative research has gained wide parlance among educational research methodologists. In spite of the more than six books and many articles on the subject, the term has eluded rigorous definition. Van Maanen notes that qualitative research has no precise meaning in the social sciences (1983:9).[1] For Wilson, qualitative research is synonymous with anthropological, phenomenological and ethnographic research (1977: 245). At least one methodologist avoids the problem of definition entirely by subsuming these terms under a broad category and then defining it. Guba chooses this route when he categorizes ethnography along with qualitative research as a

[1] Van Maanen's definition of qualitative as a "term covering an array of interpretative techniques which seek to describe, decode, translate... the meaning, not the frequency, of certain, more or less naturally occurring phenomena in the social world." (1983:9) typifies the lack of precision.

"naturalistic research paradigm," insisting, moreover, that naturalistic research is not a method at all, but a paradigm for inquiry (1981:76). Others, such as Eisner, find the term qualitative misleading, "since all empirical research must of necessity pay attention to qualities..." (1981:5). He believes that the main distinction lies between what is studied in a scientific mode, and what is studied artistically. This observation's authentic ring, however, is dampened by the novelist E.L. Doctorow who cautions that writers may "compose false documents more valid, more real, more truthful than the 'true' documents of the politicians or the journalists or the psychologists." (1977:232). Doctorow's fictional perspective implicitly highlights the fundamental question around which all discussions about qualitative and ethnographic research inevitably orbit: how is the researcher, and the researcher's audience assured of the truth of what is before them?

There are no wholly satisfactory answers. Tests of reliability and validity, the keys to judging the accuracy of empirical research, have a very restricted application in qualitative research. Beyond a knowledge of logic and an intelligent application of the facts, there are no comparably powerful tools available for testing the accuracy of ethnography's interpretative methods. One of the strongest verification procedures is triangulation, also called convergent validation, where agreement is sought between the products of two or more methods of collecting evidence

(Abrahamson 1983; Miles 1984). An example of triangulation in an organizational setting is where the interview disclosures of pharmaceutical executives are confirmed by World Health Organization statistics. Such correspondence between two research techniques enhances the belief that the results are valid (Jick 1983:136). The process of combining different methods can be traced to the multiple operations work of Campbell and Fiske (1959). Although qualitative researchers claim triangulation as their own, there is ample evidence of its earlier application by historians and anthropologists. March Bloch's *Feudal Society* (1961) and Ruth Benedict's *The Chrysanthemum And The Sword* (1974) are two benchmark studies in their respective fields which rely heavily on assembling corroborative evidence from a wide variety of sources. That Yvonna Lincoln, co-author of *Effective Evaluation* (Guba & Lincoln 1981), one of the most popular texts on naturalistic methodology, also studied medieval history provides strong indirect testimony to the epistemological roots of qualitative research.

There is little which distinguishes the core methods of qualitative and naturalistic research from either ethnography or historiography. All researchers in these fields invest selected facts with meaning in a continuing process of moulding facts to interpretation and interpretation to facts. Ethnography's concern with studying living cultures does not necessarily lead to a differentiation of its research methodology. Compare ethnography's direct

perception of the present with historiography's use of various types of recorded information. In both disciplines, a discrete observation is selected from a wide range of possible events. The ethnographic observation once noted is cast as an action that exists in the past. The recorded observation is then subject to the same discriminative process as historical fact. An event which ethnography describes usually cannot be reproduced. For all practical purposes, the methods of qualitative, naturalistic, ethnographic, and historiographic endeavour are fundamentally the same. That is why a definition that would clearly delineate qualitative and naturalistic research from ethnography has not been made. In their current use, these two expressions are little more than misleading tags for long established forms of humanist inquiry.

A. SAMPLING TECHNIQUES

The principal data sources constituted interviews with educational administrators who were employed throughout the B.C. public school system. Supplementary sources included policy documents, internal administrative studies, financial and annual reports, as well as studies on the application of electronic information technology to the public service[2] and

[2] Public service denotes the collective instrument whereby things that government is responsible for, get done. Swainson (1983:119) writes, "reflecting current governmental practice in British Columbia, (the term public service) is used to embrace the departments of government, its central and special agencies, its boards, commissions and crown corporations, and the staffs of all of them."

to business management. The administration of the public school system – whether at the school, school district or ministry level – is treated as integral to the public service. For the purpose of reporting the research findings, and discussing their implications, the British Columbia Systems Corporation (BCSC) although a provincially owned Crown corporation and therefore in the strictest sense part of the public service, will be considered separately.

Several sources were tapped for information that could be used to assemble a preliminary model about how computers have affected the modern organization. These sources included research journal articles, newspaper reports, and correspondence. Although to date relatively little has been published about the impact of computers on the administration of the public school organization, there is a well-developed literature on their corporate impact, and a small, but growing research effort has begun on the experience of government. Specialized publications on computers, management science, and information science can provide a good composite of the organizational change which the computer has wrought.

Correspondence with five Canadian educational ministries was undertaken before the fieldwork was launched in late May, 1984. The provincial experience was varied. Ontario, Manitoba, and Alberta reported that a small number of districts transferred data to the Ministry in electronic form. Quebec had developed a province-wide computer network

linking more than two hundred and fifty school districts with the Ministry of Education (Appendix E). In 1983, Ontario established the Canadian Educational Microprocessor Corporation (CEMCORP), a government sponsored manufacturing program for educational microcomputers. Although the main purpose was to supply computers for classroom use, an additional objective was to apply some of these machines to school management. Knowledge about how other provincial jurisdictions addressed the application of computers to administration, afforded comparisons with the preliminary research results of the British Columbia inquiry.

B. PILOT STUDY

A pilot study was conducted to test the interview methods. The pilot was held with a superintendent of a metropolitan school district. The interview was semi-structured, and followed a flexible schedule of questions. After close assessment of the trial results which included discussions with experienced organizational researchers, the pilot was deemed a success. The interview was completed within the designated time of one hour and the respondent replied in a forthright manner to all questions. Additional information or clarification was provided as requested. At the close, the researcher was introduced to two of the district's head office personnel, an assistant secretary-treasurer and a curriculum coordinator. In a pattern that would characterize some future interviews, an additional ninety minutes

were spent seeking supplementary evidence from them. Extensive note-taking replaced the tape recorder for the two supplementary interviews.

Some ad hoc questions which were prompted by the interviewees' responses were added to the schedule. The sequence of questions was rearranged with the intention of "maximizing the flow of information and maintaining optimum interpersonal relations..." (Gorden 1975:406). The preliminary formalities, including obtaining consent, were abbreviated. A few questions which apparently had been perceived by the respondent as threatening were rephrased.

C. CANDIDATE SELECTION

The selection process began with a knowledge-gathering phase. Limited research funds restricted the search for candidates to districts located within the region encompassed by southern Vancouver Island, the Greater Vancouver Regional District, and the Lower Fraser Valley. This conurbation is within easy commuting of the researcher's home and includes fifteen school districts. Districts with the longest history of computer use in British Columbia are to be found here; indeed, some were selected for the research sample. Input was sought from schools and school districts which had been particularly active over recent years in the administrative application of computers.

A core group of six administrators was selected for initial contact. This group included an executive director

of a research agency, three superintendents of schools, and two senior managers from the Ministry of Education. The sample was constructed to produce immediate input from as many organizational levels as possible. An additional twenty-six respondents were identified from document searches and references provided by the initial six-member target group. Discussions with representatives of professional education associations and individuals outside the educational system enhanced the knowledge gathering phase.

D. CANDIDATE PROFILES

The profiles of the initial set of public school organization respondents fulfilled the following criteria. Interviewees were administrators within the B.C. public school system who functioned as principals, vice-principals, superintendents, assistant superintendents, secretary-treasurers, or branch directors at the Ministry level. The educational respondents had many years of administrative experience in the B.C. school system. Figure II (page 65) compares the average number of years that various categories of respondent had held their current position. Most had occupied their current posting from four to ten years. The average number of years of teaching and administrative experience by respondent category is reported in Figure III. With accumulated experience averaging twenty-eight years, the secondary school principals between them had served the longest time in the system, closely followed by the

Figure II
Respondents Mean Years Of Experience In
Present Position By Organizational Level

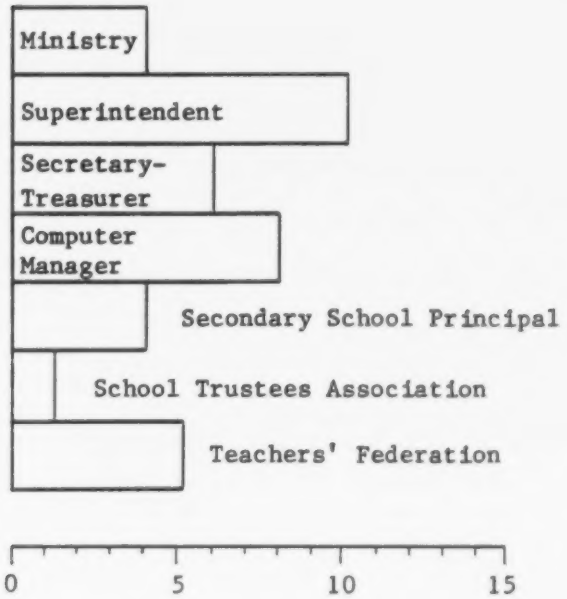
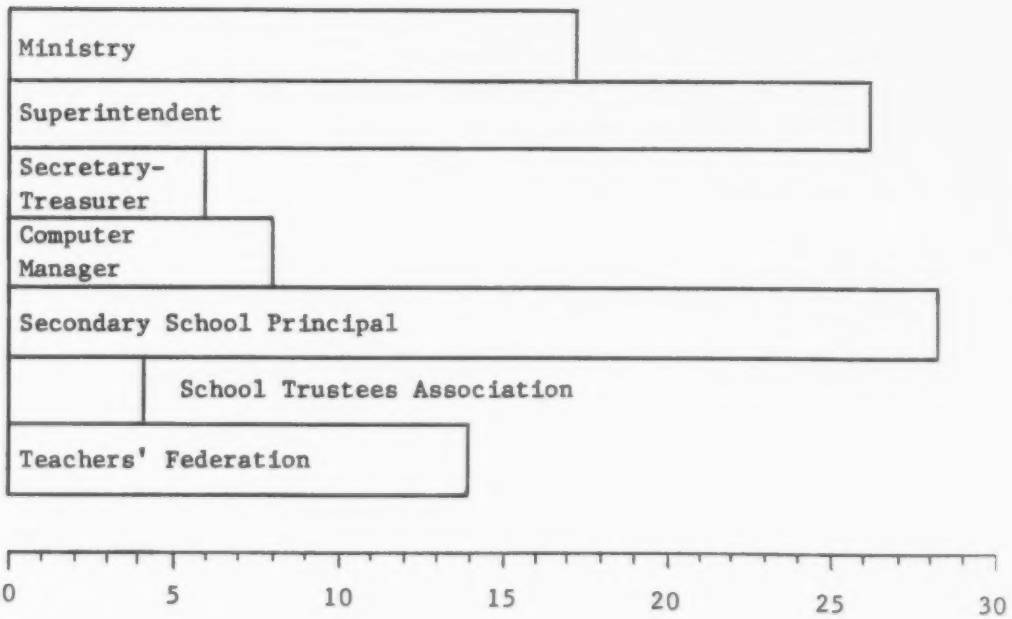


Figure III
Respondents Mean Years Of Educational Employment
Experience By Organizational Level



superintendent category with twenty-six years. These totals demonstrate that the educational respondents drew on a long working acquaintance with the B.C. school system.

Administrators belonged to organizational units which either maintained in-house computers, contracted their computer services to privately operated data processing companies or, in the case of the Ministry, contracted to a Crown corporation. Representatives were sought from organizational units in which either the microcomputer, minicomputer or mainframe predominated. In some instances, the interviewees were regarded by computer professionals and their peers as individuals who had displayed a strong interest in the administrative application of computers.

Any single school district was represented by no more than two respondents. This design feature reduced potential internal administrative conflict and increased the range of inputs. Once selected, written contact was initiated soliciting the candidate's participation. The introductory letter briefly stated the purpose of the research, the nature of the interview, and asked the respondent to indicate a convenient time. Some letters of introduction were written by the research supervisor, others by the author. A follow-up telephone call was made three days after the expected arrival of the letter. Later, this routine was changed. Letters of introduction were delivered by hand to expedite securing an appointment.

The initial plan called for respondents to be selected exclusively from the B.C. public school organization. A decision was taken early in the fieldwork to widen the sample. An improved understanding of the research questions was believed possible with a broader range of inputs. Widening the sample was accomplished in two steps. In the first, candidates were added from two closely allied organizations: the B.C. School Trustees Association and the B.C. Teachers' Federation. In the second step, respondents who had a commercial knowledge of the administrative application of computers to the province's school system were solicited from software and hardware companies.

The profiles of the non-educational respondents were more diverse both in career and geographical dimensions than those of educational administrators. Interviewees included systems analysts, software developers, and hardware vendors. Several executives of small companies were also contacted. Discussions with these respondents usually concentrated on specific questions relating to their area of expertise. Their contributions, although on occasion not explicitly related to educational administration, assisted in the analysis of information provided by the public education organization respondents.

E. THE INTERVIEWS

During the study's planning stage, one hour was designated for each formal interview. In practice, however, the interview duration averaged close to one and three quarter hours. There were several occasions in which unanticipated though rewarding interviews were conducted on the spot with members of the administrator's support staff. The number of personnel interviewed from the provincial public school organization totalled twenty-two. Table II (page 69) provides a list of interview respondents by position and organizational level. An additional seven interviews were conducted with representatives of four closely related professional organizations, the B.C. School Trustees Association, the B.C. Teachers' Federation, the B.C. Research Council, and the Educational Research Institute of British Columbia. Finally, ten representatives from hardware and software companies were interviewed. Personnel interviewed in these categories either designed educational administration computer programs, acted as advisors to school districts or served as research consultants to senior levels of government. Their professional knowledge extended beyond British Columbia to include Canada and the United States. Table II provides a detailed breakdown of respondents by organization and position. The total time spent questioning respondents exceeded fifty hours.

Table II
Interview Respondents
By Position And Organizational Level

1. Ministry of Education		
Directors		2
	subtotal	2
2. School Districts		
Superintendent		4
Assistant Superintendent		1
Secretary-Treasurer		2
Assistant Secretary-Treasurer		1
Computer Services Manager		1
Computer Coordinator		1
Coordinator Audiovisual Services		1
	subtotal	11
3. Schools		
Principal, Elementary		1
Principal, Junior Secondary		1
Principal, Junior/Senior Secondary		2
Principal, Senior Secondary		3
Vice-principal, Senior Secondary		2
	subtotal	9
4. B.C. School Trustees Association		
Administrator		1
	subtotal	1

cont'd....

5. B.C. Teachers' Federation		
Bargaining and Professional Development		2
Computer Services		2
	subtotal	4
6. Research Institutions		
Administrator		2
	subtotal	2
7. Software Companies		
Manager[1]		2
Systems Analyst/Programer[1]		1
Marketing Representative[1]		3
	subtotal	6
8. Computer Companies		
Marketing Representative[1]		3
	subtotal	3
Total Respondents		38

Note:

[1]written summary of interview only

1. Interview Schedule

Semi-structured interviews were conducted with each participant according to an interview schedule. This facilitates comparisons between interviews (Abrahamson 1983:338). Individual respondents were not required to answer each question, and the sequencing of questions varied with each interview. If the participant's answers demonstrated exceptional knowledge in an area deemed likely to enhance the study, the interviewer departed from the schedule and developed impromptu questions which more fully explored this expert knowledge. In those instances where a respondent strayed onto less productive ground, citing a scheduled question sharpened the focus. The strategy of partly scripting the interlocutor's role while allowing sufficient flexibility to determine the timing of a particular question, meant that the interviewer could more readily adapt to the respondent's individual style and experience.

As interviewing progressed, the schedule of questions was revised to reflect the improved understanding of the research implications. With experience, the schedules better anticipated the type of contribution that a respondent could make by virtue of the respondent's position and administrative experience. The revision process, together with the production of schedules tailored to particular administrative positions resulted in the further differentiation of questions.

Two administrators asked for a list of questions to be submitted three weeks in advance of the interview. Their request was granted. To the researcher's surprise, on commencing the interview the respondent began to read from a prepared list of short answers. This arrangement was stilted; although the accuracy of the information was good, the depth and breadth of the answers were very limited. When the interviewer engaged the respondent in conversation related to the questions, the respondent soon began to relax. This technique proved more productive than the preparation of short, written answers and this experience points to the inherent restrictions of the survey questionnaire.

2. Respondent's Consent

At the interview's commencement, a summary of the respondent's rights and the conditions of the interview was submitted for signing (*see* Consent Form, Appendix G). Among the important assurances were the right to decline to answer specific questions, and to withdraw from the interview at any time. Any questions concerning procedure were answered to the satisfaction of the respondent. After signing the form, a copy was retained by the respondent and the interviewer. Confidentiality of the disclosures and anonymity of the sources were ensured.

Confidentiality was achieved by not referring later to any matter disclosed during an interview in a manner which

could be considered a breach of trust. Anonymity was secured by not identifying the respondent either during the taping session or subsequently in the typed transcripts. Where references were made in this study to content which might have revealed either the identity of the respondent, or the respondent's associates, the references are designed to conceal that identity and maintain the integrity of the reference. The study's methodology here, as elsewhere, is designed to comply with the stipulations of the University of British Columbia Behavioural Sciences Screening Committee For Research Involving Human Subjects.

3. Tape Recording

Twenty-seven interviews were recorded on a portable cassette-tape machine. The small recorder's built-in electrostatic microphones faced in opposite directions and were designed to capture the speech of both discussants. Recording equipment preparation was simply a matter of plugging the machine into a convenient power receptacle and performing a sound test. Setup was kept to approximately three minutes, a time which allowed maximum use of those few instances where the administrator strictly adhered to the one hour limit. A ninety-minute cassette tape was selected because this format reduced cassette handling to one change per hour. An additional thirty minutes of blank tape remained for interviews which took longer. Disclosures of a more important nature seemed to occur with greater fequency

toward the end of the one hour period. Had the flow of conversation been interrupted by a cassette change, the information would probably have been lost. The choice of this tape format also contributed to the effective utilization of the time allotted.

Tape recording provided an accurate audial transcription of the interview. The interviewer was relieved of laborious note taking. Comprehensive note taking would have been impossible, when combined with other responsibilities, such as attention to content and the formulation of follow-up questions.

With a tape recorder, the interviewer was able to concentrate on establishing a close rapport with the respondent. Attention could focus on the content of the verbal communication, its fidelity with the speaker's kinesthetics and proxemics (Downs 1980:68), and its accord with the interviewer's understanding of the subject. A swift evaluation of the respondent's answers could be made before proceeding to the next question. Occasional brief notes either highlighted the interviewer's evaluations or identified a subject for a follow-up question. Later, the recording would allow the interviewer "to hear his own verbal techniques and detect possible biasing effects." (Gorden 1975: 474). The presence of the tape recorder did not appear to inhibit interviewee responses. The apparent neutrality of the recording device may be a product of increasing social acceptance of various recording techniques.

4. Transcripts

A verbatim transcript was typewritten for each recorded interview. There were approximately 670 typed double-spaced pages of transcribed material. Neither transcripts nor notes were presented to the respondents for confirmation, since this procedure would slow the evaluation. In addition, there was concern that respondents would alert other administrators to the content of the questions, thereby reducing the level of spontaneity. On several occasions during analysis of the written transcripts, however, confirmation was sought on a particular point from either the respondent or from other sources in the respondent's organizational unit.

More rapid and more complete analysis of the material was possible with typed transcripts than with the original audio recording. When the transcriber was uncertain about particular words or phrases, the tape counter number was included in the typewritten copy. Later, the researcher returned to these areas and identified the missing passage. The transcript incorporated methods of recording the use of presymbolic utterances, and noting verbal emphasis given by the respondent to a word or phrase.

Repeated recourse was made to the typed transcripts as the analysis proceeded. Information divulged in the interviews was checked for internal consistency, and consistency with the disclosures of other respondents. The researcher's responses to the testimony were noted in the margins.

Summaries of key points were made for quick future reference. A coding system was devised to identify the page locations of specific content used in reporting research findings. While in progress, the job of accurately transcribing twenty-seven interviews hardly seemed warranted. As the analysis of the research question matured, however, the earlier effort was justified.

Had a written summary been substituted for the tape recording/typed transcript method, much valuable material would have been irretrievably lost. The summary approach to recording interviews prematurely reduces the richness of the data. The tactic is quick, but it tends to confirm preconceived notions, since the results are mediated "by the fieldworker's own standards of relevance as to what is and what is not worthy of observation." (Van Maanen 1983:51). A verbatim transcript preserves many subtleties which await discovery and elaboration when the interviews are compared.

F. Interviewer Bias And Respondent Validity

Various means were invoked to reduce the possibility of interviewer bias and to assure the validity of the disclosures which were later incorporated into the study. A schedule of questions was followed (Appendix F). Verbatim typed transcripts reduced spurious and subjective judgements of what transpired in the interview. Since the complete interview was recorded, content analysis could proceed over the eighteen-month period of thesis preparation.

Information which might have been dismissed as irrelevant in the initial phases of the project was not lost, but remained until its significance was recognized.

Identifying interviewer bias was part of the review process that accompanied the completion of each interview. Appropriate changes were made to the schedule of questions and to the interviewer's style. The relatively large number of respondents in a study of this type contributed to improved reliability. Disclosures were compared with those of administrators at other organizational levels and with those of respondents from outside agencies. Agreement between many respondents may indicate a higher degree of reliability. However, due consideration was given in the content analysis to the recognition that overwhelming agreement does not of itself assure credibility: a minority of one may be the solitary bearer of the truth.

Where possible, interview disclosures were checked against written documents, such as studies, financial reports, policy statements, and minutes of meetings. Requests for written replies to questions were sent to respondents on the assumption that administrators take great interest in the accuracy of signed statements. Comparing the interviewees' replies with the findings of research in allied fields assisted with a determination of reliability. Most research findings in the study are supported with references to their source: public or private reports, personal correspondence or respondent disclosures.

G. SUMMARY

Qualitative research is rooted in a long tradition of humanist inquiry. Its methods are not fundamentally different from historiography or anthropology. In the pursuit of an improved understanding of social phenomena, a similar process of analysis and interpretation is shared by all three. As with quantitative research, a set of data or facts may be invested with radically different meanings. Tests of reliability and validity, keystones of scientific method, have a restricted application in qualitative studies. Clarity and the revelation of sources are the chief guarantees of reliability.

IV. RESEARCH FINDINGS

Throughout the twenty-five year history of administrative computing in the British Columbia public education system, two major trends have occurred. First, computer applications within the Ministry move from a labour replacement role in which existing clerical routines are automated, to a planning mode in which informatics assists policy-makers. In the second trend, computer use diffuses from the organizational apex to all school districts and many schools.

The effect of computers on administration is pervasive. Their capacity to manipulate large quantities of data is the backbone of the Ministry of Education's[1] current centralization program which embraces budgeting, and curriculum and learning evaluation. Without these tools, the planning, implementation and monitoring of several major policies introduced since 1982 would be prohibitively expensive. As a consequence of computer applications, the parameters of local administrative action were redefined, and school and school district autonomy eroded.

The same administrative practices that led in 1961 to the installation by the Ministry of Education of an antiquated computer, to be replaced only a year later by

[1] The Department of Education was proclaimed the Ministry of Education on October, 1977 (British Columbia 1977:551). This body is referred to throughout this study as the Ministry of Education.

equipment already nearing obsolesence, have persisted into the 1980's. Recently installed school district computers run on mutually incompatible software which restrict economies of scale and limit digital communication. At the same time that the Ministry exerts increasing control over the whole education organization, with the recording and monitoring assistance of computers, the Ministry seems reluctant to firmly coordinate school and district data processing.

Districts have long resisted centralization and standardization of their computing systems. A late 1960's study, and one a decade later recommended that the Ministry rationalize district EDP (Howe & Totherow 1969; B.C. Ministry of Education 1979). In the absence of firm Ministry resolve, however, school district policy on data processing evolved without reference to provincial needs.

The course of provincial government computing altered sharply with the 1977 founding of the British Columbia Systems Corporation. Following transfer of data processing responsibilities to the new Corporation, a small but important cadre of Ministry of Education computer professionals was dispersed. Confronted by the controversy that attended the BCSC start-up, Ministry officials seemed less favourably disposed to the implementation of provincial processing standards.

A chain of events in the early 1980's once again focused Ministry attention on district computers. In response to public service financial reforms and fiscal

restraint measures spearheaded by the Ministry of Finance, the education ministry devised a new Planning, Programing, and Budgeting System. PPBS complexity required that most school districts acquire computers with an enlarged processing capacity. Introduction of PPBS was therefore preceded by the 1982 announcement of a four-year computer expansion and replacement project.

Schools and school districts are represented by many administrative units. In 1984 there were seventy-five school districts and 1,712 schools (Statistics Canada 1985a).[2] Among these units, considerable variation exists in the manufacturing origin of hardware and software composing the data processing systems. Each administrative entity within the research sample of six schools, and six school districts[3] has a distinct constellation of manufacturer's equipment (Table IV).

Although Ministry experience with computers accumulated over twenty-five consecutive years, detailed information on the topic is scarce.[4] The Ministry's electronic data processing systems were implemented in relative obscurity; legislative debates and news media coverage do not record the historic junctures as they have for the Systems Corporation.

---

[2] In 1985-86 there were seventy-five districts and 1,692 schools (Statistics Canada 1985b).

[3] Were the districts represented by the school-level sample added, there would be a total of eight districts in the sample.

[4] Dr. C. B. Conway, the leading figure in the early years, is deceased. If he kept a daily journal, none appears to have survived. Ministry of Education papers from this period have yet to be released to the Provincial Archives.

Rarely do Ministry Annual Reports find the subject worthy of comment.

Research findings are reported in three sections:

1. Ministry of Education
2. School District
3. School.

Findings for the British Columbia Systems Corporation are disclosed in a fourth section. The recapitulation integrates the research findings in summary form. Since the events which compose the story form a complex whole, a time line is included in Appendix A as a convenient guide.

A. MINISTRY OF EDUCATION

The year 1947 marked the first time an electrically powered computing device was directly utilized by the B.C. Ministry of Education. This simple machine was the focus of a short-term study on its application to test scoring. The machine electrically detected graphite-filled answer spaces (Ministry of Education Annual Report 1964-65: 53). According to Dr. Clifford B. Conway,[5] the first Director of the Division of Tests, Standards and Research, "one machine operator could accomplish as much as three or four hand-scorers..." (1947-48:130). Machine scoring cost approximately two cents per sub-test, while hand-scoring was

[5] Conway probably saw this machine in operation while serving in the Canadian Army under General Brock Chisholm during World War II (Annual Report 1973-74:D12). He acknowledged the important influence his experience with the army M-Test played in administering the marking of provincial tests and matriculation examinations.

valued at four cents. The Annual Report indicates that the cost-benefit of the computer was amply demonstrated, but a large number of small errors resulted in test scores which were too low, soon forcing the project's cancellation.

Fourteen years elapsed before the introduction of an electronic computer. In the immediate post World War II era, the province's educational system expanded rapidly. Student enrolment in grades one through twelve climbed from 125,135 students in 1945 to 400,080 in 1965 (1978-79:156). As the volume of achievement tests and junior matriculation examinations kept pace, manual marking and tabulating methods proved slower and more costly. The additional expenses incurred in servicing high enrolments probably contributed substantially to justifying the costs of an in-house computer to Treasury Board. Treasury kept a tight hold on government data processing (Ritter & Cutt 1985).

The Ministry's initial commitment to electronic data processing came in 1961 with the installation of an IBM 650[6] to accomplish "partial mechanization of the handling of 63,000 matriculation examination scores." (Annual Report 1962-63:47). Education was probably the first Ministry in

---

[6] The IBM 650 main memory ranged from 10,000 to 20,000 decimal digits (Fisher, McKie & Mancke 1983:17). It was a smaller version of IBM's first computer (1983:15). Data was entered by keypunch cards read at a speed of 250 cards per minute. There was no visual display terminal. The machine rented for between $3,000 and $4,000 U.S. when first released in 1954 (1983:17).

In November 1985, the IBM AT personal computer had a 16 bit processor, 512 K RAM and a 20 megabyte hard disk. The package included keyboard, visual monitor and a DOS operating system – retailing for under $10,000 Canadian.

the Provincial Government to operate an in-house computer; only in fiscal year 1963-64 did the Finance computerize their accounting system (Ritter & Cutt 1985:13).

At the time of Ministry implementation, the seven-year old 650 technology already had been rendered obsolete by IBM's 1960 introduction of the 1400 system (Fisher, McKie & Mancke 1983:52). Two replacements for the 650 system, the IBM 1620 computer and 1403 printer were installed in 1963[7], as the Ministry prepared for "the tremendous upsurge in matriculation candidates expected in 1964 and 1965" (Annual Report 1962-63:47). The 1620 computer was a second generation machine with a magnetic core storage capacity of 20,000 alphameric digits (IBM 1963:2). The accompanying 1403 high-speed chain printer operated at 600 numeric data lines per minute, a considerable improvement over the 150 line rate for earlier models (Fisher, McKie & Mancke 1983:53).

Rewriting the old 650 computer programs for the 1620 took two years (Ministry Annual Report 1963-64:53), an indication that the decision to abandon the 650 hardware was made only a few months after installation. After 1963, computers assumed an increasingly central position within Ministry operations.

---

[7] The IBM 360 series was announced on April 7, 1964 (Fisher, McKie & Mancke 1983:139), proof that rapid technological obsolescence was as germane then as it is today.

1. Changing Role of EDP

As computers underwent an expanded organizational role, the administrative attitude toward them changed. This change was closely linked to how they accomplished Ministry goals. Two historic stages are discernible. During the first, lasting from 1960 to 1974, many clerical procedures are automated. Computers replaced people. Some of the remaining non-automated clerical routines are modified to accommodate electronic data processing. Administrative observations at this time stressed the labour replacement aspect of computers; demands for increased automation cite potential efficiencies and cost-benefits (1961-62:47).

A summary of computer applications published in the Ministry's 1961-62 Annual Report conveys a pronounced interest in their labour replacement potential. The Ministry computer marked and tabulated achievement test and examination results. Eight automated clerical steps are listed, ranging from hand identification of papers to conversion of raw to scaled scores. A strong plea is made for the installation of in-house keypunch machines:

> The maximum benefit of automation will only become evident when machines are installed in the Department of Education for preliminary punching operations and the whole procedure is mechanized. (1961-62:48)

This concern with computing efficiency continues through 1965, when a comparative study of two photoelectric scorers is reported. The transition from labour replacement to wholly new applications begins in 1966 when the British

Columbia Research Council (BCRC) produces an IBM 360 program for the "mathematical projection" of enrolment (Annual Report 1966-67:58).[8] Since the program is designed to handle new data inputs, the projections can be revised as additional data are collected. The effects of changes to class size, course offerings and teacher graduation were also modeled. This program is probably the first to directly inform Ministry policy-making.

During the second historical stage, beginning in 1974 and continuing to the present, computers not only continue to automate clerical work, they also undertake assignments never before required by the Ministry. They become close adjuncts to the planning process (1974-75:15). Their efficiency is usually assumed, and administrative statements about costs which dominate the first stage, give way to considerations about how best to respond to growing statistical demands that originate within either the Ministry or outside agencies (1974-75:16). Observations from this period point to the complexity of data requirements as large-scale assessments of the public school system are undertaken. The computer assumes the dual tasks of simulator and archivist. Multi-purpose data banks are devised with sufficient flexibility to handle existing statistical requirements and those in the future whose exact nature is not yet known (1980-81: 69). The Data Operations Branch aptly characterizes the

[8] According to Glen Foster of BCRC, preliminary work began in 1966 with the operational model delivered in late 1968 (interview March, 1986).

change as one that went "from 'what is or what was' towards 'what will be if.'" [sic] (1980-81:69).

In fiscal year 1973-74 the Research and Standards Branch, responding to rising statistical and data processing demands, underwent "greater expansion in one year than in the previous twenty-five" (1973-74:14). The Branch was divided into three: Learning Assessment, Information, and Data Services. Each new branch used EDP heavily. Some of the processing load was removed when school assessments of student achievement replaced provincial examinations. Data Services began work on a new management information system (MIS) "to assist the Department in the management of the whole education enterprise." (1975-76:31). In 1976, a computer was introduced to the Publication Services Branch to manage the purchasing and distribution of textbooks to the province's schools (1976-77:32).

2. Computing Expenditures and Cost Analysis

According to respondents, a commonly-held expectation of the conversion of clerical procedures to electronic routines is that they will be performed for either the same or less cost. Financial information therefore provides an important measure for gauging the administrative impact of computers. Detailed financial analysis of computer impacts on the B.C. public school system was thwarted by the scarcity of reliable information. Changes in organizational structure and accounting practice reduced the usefulness of

the small amount of financial data available.

Between 1977 and 1982, a period when Treasury Board required all ministries to publicly disclose computer and computer consultancy costs, Public Accounts report annual Ministry of Education increases in expenditure on electronic data processing (Table III, page 89). Excluding the 1977-78 disclosure, which represents only a portion of the amount spent on EDP that year, figures range from a 1978-79 low of approximately one million dollars to a 1983-84 high of approximately 1.6 million dollars. The average annual expenditure on computers and system consulting exceeded 1.3 million dollars during the seven-year period 1978-79 to 1984-85. While in the same period, the Ministry's annual average expenditure on public education (kindergarten to grade twelve) was 964.4 million dollars.

Given the data available, production of a reliable longitudinal comparison between computer and administrative costs is not possible. For several years, the Ministry's financial statements published in the Public Accounts include an administrative category variously reported under 'Administration,' 'Ministry Services,' 'Management Operations,' 'Educational Finance,' and more recently identified as 'Management Operations.' Irrespective of changing titles, this category does not represent the cost of administering the Ministry; rather it is the combined expenditure of Management Operations and Educational Finance Branches (correspondence, 1985). These branches support internal

Table III
B.C. Ministry of Education Computer Costs Compared With
Total Public Education Expenditures
1974–1984[1]
(nearest 1,000 dollars)

Fiscal Year	Computer & Systems Consulting	Total Ministry	Percentage BCSC Price Reduction[2]
1974-75		391,236,000	
1975-76		479,117,000	
1976-77		578,824,000	
1977-78	232,000[3]	627,851,000	
1978-79	1,016,000	680,776,000	
1979-80	1,298,000	673,073,000	10
1980-81	1,386,000	788,538,000	7
1981-82	1,357,000	896,897,000	7
1982-83	1,479,000[4]	984,829,000	
1983-84	1,653,000[4]	1,033,841,000	
1984-85	1,516,000[4]	1,065,122,000[5]	

Notes:

[1] Sources: Public Accounts of British Columbia, and BCSC Annual Reports

[2] Price reduction in percentage over previous year

[3] Figure represents only part of the 1977-78 total. No entries appear in earlier editions of the Public Accounts.

[4] Supplied by Ministry of Finance

[5] British Columbia Estimates for fiscal year ending March 31, 1984, page 61

ministry and external school objectives (correspondence, 1985).

Another change which reduces comparability is that since 1982, in order to conform more closely with the needs of Treasury Board, the emphasis in budget preparation has been on the assembly of information at the program rather than the operational level (Ritter & Cutt 1985:47). Votes are no longer distributed on an expenditure basis; now they are allocated to program objectives. Administrative and data processing costs are charged to each program within the Ministry and are not itemized in the Public Accounts.

Were the B.C. public school system's administrative and computing costs available to the researcher for fiscal years 1982–1985 – which they are not – their significance would be subject to broad interpretation. Effective April 1, 1981, the Comptroller General altered the method of accounting from a cash to an accrual basis. Additionally, there have been three reorganizations of the Ministry of Education: in 1980-81, when responsibility for universities was transferred to the new Ministry of Universities, Science and Communications, followed by two internal reorganizations in 1982-83 and 1985-86.

BCSC service charges fell by ten percent for the 1979-80 fiscal year, and seven percent for each of the following two years (BCSC 1979-80:4; 1980-81:5; 1981-82:6). These reductions apply to a large proportion of Ministry data processing expenditures, and are interpreted in this

analysis as productivity gains.

Although outside agencies such as BCRC and the Education Research Institute of British Columbia (ERIBC)[9] received some data processing contracts, BCSC's strategy was to increase control until virtually all government processing development was channelled through the Corporation (*see* Research Findings, D. British Columbia Systems Corporation). By fiscal 1981-82, this corporate objective was largely achieved (BCSC 1981-82:12).

Fiscal 1981-82 also marked the beginning of an official four-year program of financial cutbacks to the public service, referred to as fiscal restraint (British Columbia 1983a).[10] This social austerity program, according to some respondents, had reduced the effectiveness of public education. Total Provincial Government expenditures continued to climb, but inflationary effects reduced the actual purchasing power.

The Ministry benefited from the production of a capital budgeting program which ran on a micromputer:

> In September 1982 work began on the development of a microcomputer support system for capital budgeting to replace the existing inadequate computer system. The new system provides estimates of debt servicing costs and compares estimates to actual expenditures. The system has been implemented in all ministries which have significant capital budgets.
>
> (Ritter & Cutt 1985:50)

---

[9] ERIBC is a non-profit education research agency located in Vancouver, British Columbia.

[10] The fiscal restraint program was announced on February 18, 1982, although key legislation such as the *Public Sector Restraint Act* and the *Education (Interim) Finance Amendment Act* was not proclaimed until October 26, 1983.

Production of this program heralded the growing influence of microcomputers in the public service, and the relative decline in the importance of highly centralized facilities in a growing number of applications. On August 31, 1983, the Minister of Finance announced that the Provincial Government would seek a private purchaser for the Corporation (BCSC 1983-84:18, Danylchuk 1983b:A3). This decision was eventually reversed, but BCSC, which had made a heavy commitment to mainframe processing, experienced a major reorganization (BCSC 1983-84:18). The concept of Information System Branches (ISB) located on client premises and staffed by BCSC personnel was implemented in all ministries (BCSC-84:6).

3. Ministry's School District Computer Acquisition Policy

The B.C. Ministry of Education has not yet developed comprehensive criteria for the acquisition of administrative computers, nor is development of such a policy imminent. Apart from some general guidelines on computer cost-sharing between Ministry and school district, and an outline of the approval procedure, the Ministry's involvement is minimal (Appendix B). In practice, choice of hardware and software vendor rests mainly with the district, a striking deviation from the centralized procedure regarding heavily computer-dependent policies, such as finance and the measurement of student achievement. The skeletal stipulations regarding computer selection are an anomally in a central educational

management accustomed to efficiency and cost-cutting. The less than fully coordinated drive toward improved computerization at the school district level produced significant additional costs and some organizational discontinuity (*see* Research Findings, B. School District).

4. Management Information Systems

The proposition that the current Management Information System (MIS) is closely integrated with and subsumed by the financial management of provincial education was confirmed during an interview with a senior Ministry administrator:

> The MIS is but one component of a new system of managing education in the province... that we are calling the new Financial Management System (FMS).

For this respondent, as with many others, the term Financial Management System is synonymous with PPBS. The new MIS emerged from the Office and Data Technology Branch, to become broadly based within the Ministry. He offered the following summary:

> It's a determination of what critical data elements are needed by this Ministry to run its new Financial Management System... and it's the output records which are being generated by the Ministry.

One of the key issues in Planning, Programing, and Budgeting Systems is who has access to the Management Information System. Information that is accessed only by Ministry analysts contributes to centralization. The data will be used by senior management to support their policy initiatives. Information accessed by lower organizational levels tends either to neutralize the centralization forces, or move the

organization toward decentralization. If individual school boards can make detailed comparisons of their operations with the financial performance of other districts, then they will be capable of more forceful budget arguments.

Budget allocations derived from information collected by the MIS are a major source of conflict between some school boards and the Ministry. During this study, the Minister of Education dismissed two school boards for submitting budgets which exceeded provincial guidelines. The Vancouver School Board was dismissed on May 5, 1985 and the Cowichan Lake School Board on May 13, 1985. Elections to replace the appointed trustees were held in both districts on January 30, 1986.

The Ministry respondent encapsulated the matter in these terms:

> Is all the information that we collect going to be analyzed, and (are) these analyses to be fowarded back to the field, or will the information analysis be retained by the Ministry with only selected bits going to the field?

Embedded in this response is a tacit acknowledgment that the Ministry did not possess the resources to analyze the increasing amounts of PPBS generated data that was flowing from the school districts. The capacity of the Ministry to analyze the increasing amounts of PPBS generated data was in doubt. Although there had been previous attempts to reduce the number of forms, the total required of school districts stood at one hundred and eighty-six, and seemed to be rising. Deputy ministers had identified forty additional

output reports they wished to have produced. An interdepartmental committee was drafting a set of MIS recommendations. These output reports would compare different parts of the MIS, for instance, enrolment, budgeting, examination results, and budgets produced by the school district against what is generated by the fiscal framework.

When asked whether he thought the Management Information System would result in reduced operating costs, a Ministry informant gave this reply:

> I don't think (MIS) was an economy measure by any means – in fact, in the short term I think they are going to be spending, from my observations, more money on systems development, as this system is put in place, and that the long-term efficiency or dollar saving is a decade or more down the road.

A microcomputer is used to analyze the fiscal framework for the seventy-five school districts, in terms of each function and the amount the districts budget within each function. Some districts are already producing their own budget analysis with microcomputers (Kelk 1985:B1).

5. Repatriation of Electronic Data Processing?

The unsuccessful attempt to sell BCSC coincided with the Ministry's 1983-84 reintroduction of compulsory grade twelve provincial examinations for students entering post-secondary technical and academic institutions (Jeroski, Tolsma & Labercane 1984:2). During the previous nine years, only those secondary school students who pursued scholarships wrote provincial examinations (Ministry Annual Report 1972-73:E29). Final standing of most students was

determined by their school.

The increased costs associated with hiring additional clerical personnel to mark and tabulate provincial examinations and tests, had provided the initial incentive for the first computer installation in 1960. In the years following 1960, considerable effort was expended on improving the application programs used to generate computations for examinations and tests, however, neither the programs nor the hardware to run them appear to have survived BCSC's 1977-78 assumption of EDP responsibility. Confronted by a Corporation with an uncertain future, and by funding cutbacks that made returning to an in-house system infeasible, the Ministry contracted the work to ERIBC.[11]

6. Computing Facilities in Transition

Computing facilities are in transition at all levels of the B.C. public school system. To some extent this transition is driven by technological change. Hardware manufacturers are marketing smaller, yet more powerful computers that can be installed in school offices without constructing special electrified and air conditioned machine rooms. Software manufacturers market proprietary products that allow school administrators to perform many functions on

[11] ERIBC's initial management of the examination contract caused serious delays in the release of marks to students (Times-Colonist 1984b:A-4). Some professional schools at B.C. universities refused admission to students who had maintained first class averages, because data processing delays meant that the Ministry could not send transcripts before the application deadlines expired. (1984a:B-11).

stand-alone personal computers that previously were confined to relatively expensive minicomputers. Private sector, school and school district respondents recognized that the advent of small, inexpensive microcomputers and powerful software suitable for a variety of school-based tasks had resulted in growing demands for computers by school administrators (*see* Research Findings, C. School).

7. Were BCSC's Systems Development Charges Too High?

According to one Ministry of Education respondent, BCSC's development costs for a statistical modeling program designed to run on the Corporation's mainframe was estimated at two hundred and fifty thousand dollars. The model would have projected the effects of changes in property tax to the fiscal framework. Development of this mainframe computer program was not approved; instead, the Ministry purchased two Apple microcomputers. The Ministry administrator compared the mainframe and microcomputer development expenses:

> ...data processing costs were estimated to be a quarter of a million dollars to get the system in place. We did it with two Apples for five thousand dollars – we now have three IBM PC's... the total layout for equipment is well under one hundred thousand dollars. It does many jobs besides fiscal framework.

The equipment, including software, is more likely to have totaled less than fifty-thousand dollars. Each personal computer had a hard disk, a printer and some off-the-shelf software. As the respondent stated, there is the additional benefit of using the in-house systems for other purposes.

The BCSC estimate is deemed by the respondent as not excessive for mainframe program development. Successive attempts at describing the exact nature of the task to systems analysts and programers were expected to consume a large portion of the total. These refinements meant additional development costs and postponements in use; outcomes that were avoided with proprietary software where utilization closely followed basic mastery.

Although the respondent asserted that BCSC personnel costs were "very, very expensive..." and constitute the largest expenditure when dealing with the Corporation, he also affirmed that their mainframe rates were low, so that "we can't cost-justify the purchase of our own equipment." The alleged pricing structure may have been associated with Corporate attempts to slow the advance of microcomputer applications within the public service (*see* Research Findings, D. British Columbia Systems Corporation, 5. Corporate Control of Microcomputers).

8. Multiple Keyboard Entry of Data

Ministry and district respondents concurred that transfer of data on schools operations would be more efficient were it accomplished electronically. Current practice requires districts to enter and process the data on their computers. Selected summary data from printouts are manually transcribed by clerical personnel to forms for Ministry

of Education use.[12] A Ministry respondent stressed:

> We rely and will continue to rely on the school district office to aggregate much of the data that comes from almost thirty-thousand teacher returns.

When the completed forms arrive at the Ministry, the information is once again manually keyed into a computer. Nearly all district-to-Ministry large-scale operational data transfers follow this procedure. After repeated efforts to streamline MIS and reduce the number of forms – a process dating at least to 1977 – the Ministry again is heavily burdened with paper. More than 120,000 forms were processed by keyboard during the 1982-83 fiscal year, with approximately half entered manually during October to December (Annual Report, 1982-83:57).[13] Second shifts were required. Undoubtedly, the new Financial Management System has brought further proliferation.

Two impediments prevent procedural streamlining: 1.) school district computers do not conform to a single operating system standard and, 2.) software applications are not written in a single programing language.

Despite the 1982 ministry directive requiring all district purchases to meet BCSC approval (Appendix B), acquisition of mutually exclusive operating systems and compilers continued (Table IV). Provincial operating and application

---

[12] Contrast this labour-intensive method with electronic data transmission procedures already common in other Canadian provincial education systems, Manitoba and Quebec for example (Appendix E).

[13] This figure excludes the processing of Ministry forms by the B.C. Research Council and ERIBC for the Ministry of Education.

system standards facilitate data exchange. Digital transmission of data would reduce costs associated with the manual processing of forms, and repetitious data entry.

Each level of summation reduces the data's potential sensitivity to small-scale variations in operational performance. An objective of the Ministry's planning, programing, and budgeting system is to identify efficiencies. Were school district financial databases accessible to the Ministry, planners could devise policies which respond better to differences in school and school district organization.

The provincial capacity to assess learning on a classroom, school and school district level, has not been extended financial performance.

9. Electronic Transmission of Data

Limited data transmission between the Ministry and outside agencies was noted. The Ministry currently sends magnetic tapes containing statistical information to Statistics Canada and the British Columbia Teachers Federation.[14] The 1976-77 Ministry of Education Annual Report states that data tapes are also sent to the federal Department of Education in the United States of America.

Data is not sent between the Ministry and school districts in electronic form and, of course, no facility is in place for accessing data bases at either of these

[14] Respondents representing Statistics Canada and BCTF complained in 1984 of unusual delays in receiving this data.

organizational levels. A Ministry respondent indicated that systems compatibility was once again under consideration:

> We are looking forward to, and beginning to consider, the possibility of electronic transmission, and we are beginning to investigate the possibility of compatibility of school district systems and our systems.

This is not the first time that B.C.'s public education organization has considered this important aspect of its computer services. Studies emphasizing computer compatibility were published as early as 1968 (Howe and Totheroh 1969).

10. Summary

Computers continue to replace people in the performance of routine Ministry work, but increasingly, new types of work are found for these machines. They are having a major impact on policy development. The strongest example of this impact is the Program and Budgeting System financial reform. The Ministry's PPBS was developed with microcomputers. Today, the Ministry compares school district budgets on a microcomputer. Increasing Management Information System reporting demands required of school districts seem to be negating previous reductions in the number of forms.

Lack of detailed financial information on data processing expenditures, which was accessible to the researcher, prevented a cost-benefit analysis of their impact. A sharp boundary was noted in the use of computers by administrators and clerks. Senior managers were not using computers in

their work. Their data entry needs were met by clerks and specialized personnel.

B. SCHOOL DISTRICT

In a period spanning over two decades, computers were adopted by all seventy-five British Columbia school districts, and a growing number of schools, to perform routine administrative tasks. Most of this growth took place during the past five years. The expansion of electronic data processing to all levels of the B.C. public school system occurred with minimal Ministerial direction. District decisions in many instances took precedence over provincial data processing standards and objectives. The fostering of electronic communication links and data exchanges using existing provincial facilities was not an explicit objective of the 1982 Ministry of Education computer policy.

1. 1969 Plan for Regional Data Processing Centres

As early as 1968, British Columbia school boards expressed serious concern with the rising costs of electronic data processing (BCSTA 1969). A survey that year showed that eighteen school districts already used some form of electronic data processing equipment or service (Howe & Totheroh 1969). District EDP costs for the province were estimated to be $225,000, with over $175,000 of this amount spent by metropolitan Vancouver school boards (BCSTA 1969:1). One year later the number of districts using EDP

had climbed to twenty-eight for an estimated total expenditure of $300,000. To contain these costs, BCSTA recommended that the Ministry immediately establish regional educational data processing centres (1969:1). Each centre would service 100,000 students (Howe & Totheroh 1969:21).

A major study completed in 1968 by the Educational Research Institute of British Columbia issued this warning:

> If a regional centre is not developed, then many of the districts will acquire data processing equipment, expand existing EDP facilities, or contract for services. This will lead to a diversity of systems and duplication of hardware with the resultant sky-rocketing of costs.
>
> (Howe & Totheroh 1969:1)

To avoid a one million dollar program development cost (1969:4), the study recommended adoption of the California student and personnel service system. If the California system were not adopted, the authors urged that $500,000 should immediately be reserved for comprehensive system development over the next five years (1969:4). This estimate did not include operating costs. Demonstration of an integrated school district management system was expected in California during the 1969-70 fiscal year. This program processed various business functions, classified personnel, and professional personnel records (1969:8).

The report did not consider computer location a prime factor in the development of British Columbia's regional EDP centres. Centralization, however, would reduce the disparities that might develop if several agencies and multiple districts were to develop their own systems (1969:2). The

plan would be achieved within a two-year horizon.

The education finance formula and the accounting practices of the time militated against the emergence of regional data centres. Therefore, immediate Ministry of Education intervention was required (1969:5). The proposed role for the Ministry included policy development – to ensure a "common computer language" consistent with Ministry needs. The British Columbia School Trustees' plan called for establishment of two regional centres in the Lower Mainland of British Columbia. Although a provincial EDP service centre had already been implemented in Quebec (Appendix E), and regional education processing centres, after seven years of analysis and design, were operating successfully in California (Howe & Totheroh 1969:4), no action was taken by the British Columbia Ministry.

2. 1978 School District Computer Needs Report

In 1978, lower mainland school districts were again the focus of a computer needs study undertaken on this occasion by the Ministry. Those participating in the review committee included the Ministry of Education, and the districts of Vancouver, Burnaby, Coquitlam, Delta and New Westminster. At their request, the districts of West Vancouver, North Vancouver and Richmond were excluded. The study determined that in the areas of personnel/payroll, purchasing/stores, audio-visual, general accounting and student services, established procedures warranted standardized hardware and

software (Ministry of Education 1979:12).

The report found that two proposals merited further study. The first sought a centralized service patterned on the regional data centres plan of a decade earlier. Each centre would be operated by five data processing employees. Short-term contracts would be issued for specific systems development. The report concluded sparingly that a centralized system "appeared to present some cost-benefit..." (1979:5). The second proposal called for distributed data processing centres. An agency under joint control of participating districts (1979:7) would coordinate equipment purchases and collectively develop applications. All equipment, operating systems and programs were to be standardized.

Concern was expressed in the report that inter-district disagreement over centralized hardware, and the potential domination of the system by the largest districts made the centralization option less attractive than decentralization where "agreement on common separate hardware seemed a relative possibility..." (1979:8).

The 1978 study stopped short of describing how the EDP project should be managed. Although the need for a new agency was recognized, no resolution was offered for what could prove a serious operational conflict: how would the agency have sufficient power to impose standardization (1979:6) and yet remain under the districts' control (1979:7)? The obvious solution, to invoke Ministry

authority, ran counter to the intention to make the agency answerable solely to member districts. The fact that there was Ministry representation on the planning committee renders the apparent failure to resolve this fundamental conflict less explicable. The Ministry's weak advocacy of centralization may be traced to the public service disfunctions that accompanied reorganization of provincial government EDP under the 1977 System Act (*see* Research Findings, D. British Columbia Systems Corporation). In sum, the report retreats from the BCSTA call, made ten years earlier, for a strong Ministry presence. Where the earlier report produced a plan and a timetable for achieving regional educational data centres, the 1979 report is silent. Circulated to all provincial districts as a discussion paper, the report became the foundation for formulating policy on the 1982 school district computer project.

When planning began in 1981 for the British Columbia school district computerization project, a trend toward an integrated informatic approach had been evident for almost a decade in some Canadian public education jurisdictions (Appendix E). While elsewhere education ministries were intent on either introducing or expanding computer networks, British Columbia reproduced much of the old technological disjunction that had characterized its pre-1982 school district computer systems (Table VI and Table VII). A new opportunity was lost for integrating these distributed data processing systems.

Table IV
Computer Manufacturers, Models, and Operating Systems
Represented in the 1984 District Sample

	Manufacturer	Model	Operating System[1]
1.	Digital Equipment Corporation	VAX 11/750	VAX/VMS
2.	Honeywell	Level Six +DPS 6	GCOS
3.	IBM	38	CPF
4.	IBM	4331 Group 2	DOS-VSE
5.	Management Assistance Incorporated	Four 400	BOSS

Note:

[1]VAX/VMS, GCOS operating systems incorporate the Standard Network Architecture X.25 protocol. Refer to Acronyms for full name of operating system.

3. Computer Systems in the Research Sample

Of the five manufacturers and over six models to receive Ministry funding approval since fiscal year 1982-83 (Ministry and school district correspondence), five manufacturers and five models were represented in this study's six district sample. Table IV lists the computer manufacturers, models and operating systems included in the research sample. Not one of the six computer models had an operating system fully compatible with the others. Program procurement and development were usually managed on a district by district basis.

Only two districts in the six district sample had identical models and operating systems. These districts freely exchanged programs and shared in updates and the development of new applications. Administrative respondents acknowledged the savings which this practice gained. Although the two districts belonged to a loose consortium of six British Columbia school districts which owned Management Assistant Basic Four business computers, their applications development was independent of the other four. Respondents from the two districts stressed that differences in the size and complexity of school district operations precluded their larger participation in the consortium. Although such differences may have applied to the smaller Interior district members, a third metropolitan district has a comparable number of students and teachers. The three annual budgets were also similar in size. District demographics and

administrations do not appear to be remarkably different. Regional political differences may have impeded greater cooperation with the third metropolitan district on systems development.[15]

4. Increased Ministry Control

The 1982 School District Administrative Computer Program marked a new stage of increased Ministry involvement in district electronic data processing. Previously, the choice of computer model and manufacture was exercised mainly by the districts. Under the new policy, all district computer purchases would receive prior approval by the Ministry of Education, Treasury Board and the British Columbia Systems Corporation (Ministry of Education 1981; correspondence).[16] The policy's wording is explicit:

> School Boards contemplating acquisition of information systems technology for which the Ministry will cost-share are required by both Treasury Board Directive and the B.C. Systems Corporation to provide evidence of comprehensive Information Systems Plans... British Columbia Systems Corporation will evaluate Information Systems Plans and equipment requests pertaining to the acquisition and/or operation of information systems technology, and based upon the review, will make recommendations to the Ministry for systems support.
> (Ministry of Education 1982a:3).

This clause ensures that school district computer

---

[15] The district respondents were not explicit about the reasons for the failure to establish close systems development ties with the third metropolitan district. The author suggests that political differences are at the root of this conflict, but a clear determination of cause requires further research.

[16] Refer to Appendix B for the 1981 British Columbia Ministry of Education policy on school district computers.

installations are compatible with the information systems strategy of the Provincial Government (1982a:3).

The policy was shaped by an advisory committee convened in fiscal year 1981-82. Superintendents, secretary-treasurers, and administrators from several Ministry of Education Branches and the B.C. Systems Corporation were represented. Following the May, 1982 implementation, a steering committee of similar composition coordinated the introduction of new computer systems for eighteen months. Administrative responsibility for the program was eventually absorbed by the Schools and Management Operations Branches (correspondence, March, 1985). The 1982 policy remained in effect for four years with only minor changes made in 1983 to the cost-sharing formula.

The B.C. Systems Corporation subsequently distanced itself from the policy's formulation and application. In a personal letter to the author written in early 1985, a senior Corporate executive emphasized, "The policy and program is not BCSC's but remains solely that of the Ministry of Education..." The computer policy, however, was produced by the Ministry in consultation with school district representatives and the B.C. Systems Corporation; furthermore, it stipulates that the program will conform to government policies on computer acquisition. Given this directive, an important expectation of BCSC's evaluation procedures would have been that the seventy-five school district installations comply with Provincial Government standards and were

Table V
Standard Equipment for Fourteen Member
Consortium of Small School Districts[1]

1.) DEC PDP 11/23+ with 512 KB memory
2.) RSTS-E Operating System
3.) 2 - RL02 10 MB Hared Disks[2]
4.) 2 - VT 101 Terminals[3]
5.) 1 - LA100 240CPS Printers
6.) SRB International Limited software applications

Note:

[1]All hardware manufactured by DEC
[2]School District #21 has a 32 MB disk drive
[3]Time sharing up to eight terminals

fully compatible with each other.' In most cases, this objective was not realized. Operating systems and application programing languages are diverse. Corporate insistence that responsibility lies with the Ministry alone seems a tacit recognition that policy implementation fell short of expectation.

BCSC's greatest influence in the realm of standardization was achieved as a planning consultant for the small school district computer project. The consortium was formed from fourteen of the smallest school boards which were financially unable to retain consultants. Digital Electronic Corporation PDP 11/23+ microcomputers were selected (Table V). SRB International supplied the

applications. All hardware and software was purchased collectively. This purchasing practice was so successful that the Ministry of Education declared:

> The program included the formation of a consortium of small school districts, which, with the assistance of personnel from the division, was able to obtain, through collective planning, a computerized system costing substantially less than any that could be achieved through individual effort previously.
>
> (Annual Report 1982-83:56)

Standardized applications and operating systems among the fourteen districts will facilitate the exchange of data and the use of the computers for communication, if such is required by the Ministry. BCSC's close involvement with the small district consortium (personal correspondence, 1985) is an exception; Corporate expertise and objectives do not appear to be reflected in most district installations.

BCSC collaborated with Ministry personnel on the formulation of new computer standards for school districts (correspondence, 1985). These new requirements were introduced in 1982. An immediate effect of increased BCSC and Ministry involvement can be traced by comparing Table VI with Table VII. During 1981, one year before the introduction of the acquisition policy, sixteen computers representing seven separate manufacturers and seven operating systems were purchased. By 1984, three years after introduction, the total number of manufacturers was halved: twenty-six computers representing three manufacturers were acquired.[17] Even in

[17] A small minority of districts installed their computers in the year following Ministry funding approval (correspondence, February, 1985).

Table VI

British Columbia School District Central Office Computers By Manufacturer

1973 — 1981

Manufacturer	Models	Year Purchased and Quantity									Total by Manufacturer
		'73	'74	'75	'76	'77	'78	'79	'80	'81	
Burroughs	2	1							1		2
C.B.M.	1									1	1
Data General	1									1	1
D.E.C.	5					1			1	3	5
General Automation	1							1			1
Honeywell	2								1	9	10
M.A.I.	4			1	1	1				1	4
Milacron	5						5	3	2	1	11
Mohawk	1								1		1
N.C.R	2		1		1						2
TOTAL	24	1	1	1	2	2	5	4	6	16	38

this post-1982 policy period, the three manufacturers' operating systems were incompatible. IBM's stronger standing in the final year of the program may presage a greater future presence.

Each operating system requires separate programs written in its specialized applications language. Some programs are Canadian variations of U.S. produced programs, while others are completely developed in British Columbia. Due to these system disparities, vertical and horizontal electronic network integration is virtually non-existent throughout most of the British Columbia public education organization. This restriction was generally recognized by Ministry and district respondents. A secretary-treasurer concluded:

> Networking is just not feasible. You look at an operation somewhere and its got a whole investment in a particular DEC, or a particular whatever– IBM, I don't know, and then try to shuffle those back into some sort of network. I have difficulty imagining the amount of energy that would have to go into such a project.

Along with the loss of networking, vanishes the possibility of shared administrative databases and expert systems. The rapid expansion in school district electronic mail subscriptions that developed parallel to the computerization project indicates that a need exists for these systems (BCSTA 1984b: 5 & 1985:2). The Ministry, refusing at first to subscribe to the Envoy service for district administration, finally relented (Heinrich 1985:10). A simply designed legal opinion database is already offered by the British Columbia School Trustees Association, but access is limited to BCSTA

members. Access also involves subscription and fee-for-use charges by Envoy.

5. Decentralization of District EDP Services

Two districts were identified in the study's six district sample as having implemented strong standardization policies on school purchases of administrative computers. With only one exception, these policies do not specify that school installations of personal computers must be compatible with the district's central office computer.

A trend began in 1981 in those few school districts which had serviced schools from a computer located at a remote commercial or central office site to move the data processing facilities to the schools. However, two school districts in the research sample were maintaining their networked data processing services, and two other districts had plans to introduce networked services when finances allowed. Networked equipment at the secondary school level includes a visual display terminal, keyboard, and printer connected by telephone line to a mainframe. Batch services are supplied to the schools by either a company or the district's data service department. Centrally located high-speed printers produce most reports. Slow-speed printers situated in some schools allow limited local output. Most data entry and output is performed at the central office. Typically, a courier delivers school data entry jobs to the EDP centre for batch processing. The completed work is

returned to the school within two days (respondents). Specialist data entry clerks are employed to handle input. With clerks concentrated at a central location, work schedules can be adjusted to changes in input loads. At times of high input, temporary employees are hired and extra shifts arranged.

There is appreciably less flexibility when data input is wholly confined to school microcomputers. A single keyboard allows only one person at a time to enter data. School level completion of data entry for student records may take one to two weeks each term. Some vice-principals report that they worked overtime at night and on the weekends to complete the process (*see* Research Findings, C. School, 5. Indirect Labour Costs).

In recent years, several private companies have produced microcomputer programs for school and student management. For at least one company which had supplied computer services to schools, the number of clients expanded to the point where by 1983 an acceptable turn-around time between data entry and data processing could no longer be guaranteed in all cases. Columbia Computing Services Limited responded to the overload problem by rewriting their mainframe program for the DOS operating system used on IBM the PC XT and PC AT computers. According to some respondents, Columbia's decision to offer the school management package in this form received added stimulus from the commercial success of the

HARTS[18] Apple II+ microcomputer program for school administration. The HARTS program is presently designed for schools which enrol up to 1,500 students (correspondence, March, 1986). Columbia's mainframe had served schools with enrolments of more than 3,000 (respondent).

Recent studies of the administrative use of microcomputers in British Columbia schools recorded the enthusiasm many school managers display for these machines (Sale 1982; Binns 1983; Gatley 1984). Indeed, several administrators interviewed for this study remarked that the microcomputer led to more responsive data processing. Most school administrative respondents assert that they control a technology previously thought remote and inflexible.

Only one of the six principals interviewed, expressed a strong preference for a central data processing service. He stressed that a centralized network of school terminals supported a range of services that could not be offered by a solitary school-based microcomputer. Some of the computing services currently available to schools in his district included audio-visual booking, library circulation and student records transfer. Transfer of student records is deemed especially important, given the degree of family mobility. Delivering records by mail, to arrive at their destination up to one week after the student, no longer was acceptable. When transferred electronically, records often arrived before the student; counsellors were then able to

[18] HARTS and Columbia have head offices in Vancouver, British Columbia

make informed judgements.

6. Capital and Operating Costs

Obtaining a clear figure for computing expenditures at the district level does not appear possible at this time. Public access to school district accounts is restricted to brief annual financial statements. Of the summaries examined, none contained items relating to electronic data processing. Although all provincial ministries were directed by the Ministry of Finance in 1977 to include computer and computer consulting costs as a separate item in their annual submission to Public Accounts,[19] the Ministry of Education did not similarly instruct school districts to publicly report computer costs.

Districts apparently are not required to regularly submit detailed accounts of their computer operating expenses to the Ministry. Current practice is to distribute these costs among individual educational program expenditures, for example, legal and xerography expenses (respondents, BCTF 1984a:31). The Ministry, however, may have the means to extract computer costs from the annual district financial submissions. The British Columbia Ministry of Education does not keep records of the microcomputers which are acquired by the districts for school administration (correspondence, September, 1984). No provincial procedure

[19] In fiscal year 1982-83, Treasury Board abandoned the practice of including computing expenses as a line item in the Public Accounts.

exists for evaluating district hardware and software. These policy lacunae arose after the Ministry's hard-won experience of the 1960's and early 1970's was dispersed in 1978 along with its computer specialists.

On average, the Ministry has committed over one million dollars toward district computer acquisition for each of the four years commencing in 1982. A similar level of expenditure will probably be required as machines are retired within the five-year replacement cycle noted by several respondents.[20] The long-term provincial trend, demonstrated by comparing the systems acquired in the 1982 program with those previously catalogued by the Ministry (Ministry of Education, 1982b), is to larger and more complex in-house computer systems. Greater processing power and program complexity come at an increased price. If past behaviour is an indication of future performance, then a substantially larger financial commitment than the estimated one half of one percent of the total provincial expenditure currently spent on data processing capital and operating costs will be required. With no centralized agency in place to make continuing assessments of school and school district computers, and an apparent reluctance to maximize the use of professional advice from other areas of the Provincial Government, provision of an informed planning leadership that seeks to optimize informatics cost-benefits will be

[20] An analysis of the 1981 British Columbia School District Computer Systems Catalogue (Ministry of Education, 1982b) and subsequent acquisitions confirmed that on average these computers are replaced every five-years.

difficult.

The 1981 computer acquisition policy states that district computer plans should allow eight dollars per pupil on average for set-up charges, and four dollars for operating costs (Ministry of Education 1982a:3). When the original capital allowance is multiplied by the province's 1982 full-time equivalent enrolment of 507,955 students (Ministry of Education 1984:122), the Ministry's capitalization share, over the four-year life expectancy of the project, will total in excess of 4 million dollars. This formula, however, was soon increased. An information circular titled *School District Administrative Computers* dated March 14, 1983 announced that shared capital funding will be increased "to a maximum of $12.40 per pupil for core applications on a cost per application basis..." The revised formula brought the total possible four-year provincial expenditure to approximately 6.3 million dollars. Using the 1982 formula and enrolment, the Ministry's total annual share for operating expenses exceeds 2 million dollars. The allowable school district share of capital and operating costs was not identified. Some respondents indicate that their school boards would spend more on computerization if they were released from fiscal restraint. With respect to local expenditures on computerization, a superintendent commented:

> Our Board would be quite willing to spend far more money to get computer hardware because that is totally locally-funded. But it is frozen by the Ministry, and so it has limited us to somewhere in the vicinity of one hundred to one hundred and fifty-thousand dollars for new equipment totally.

As restraint measures are relaxed the desire for expanded and improved computer facilities may translate into larger school district outlays.

Estimates of computer system expenditures supplied by school district administrators varied on a one-shot basis from one-hundred and thirty-thousand dollars, to two-hundred and seventy-five thousand dollars. One superintendent, whose district was not the largest surveyed, claimed that computer expenditures in his district were considerably higher. His justification for these costs is contained in the following:

> As you can imagine, we've spent a fair bit of— six or seven hundred thousand dollars on computers. But if one could appreciate that in a matter of a year and a half, when we went internally with our payroll system, our bank charges went down twenty-thousand dollars a year, but, more importantly, we went from six people in the payroll department, plus a supervisor, to two clerks. That is a payback between the student administration system and the payroll application, that system was paid for in two years.

Even allowing for distribution of these costs over several years and the elimination of some external service expenditures, the total seems high.

Transfer of EDP responsibilities from outside agencies to the school district office causes a reallocation of some charges. The acquisition, maintenance, and operating costs associated with data processing systems which were once distributed among all users of the commercial operation are now borne solely by the district. The cost of an in-house system may be considerably higher than leasing online or

batch services from a data processing company. By fiscal year 1983-84, the Ministry of Finance responded to these long-range operating differentials by insisting that all public service Information Systems Plans were to include a five-year cost comparison of in-house and service centre data processing (correspondence, 1985).

7. Software Development

Two districts represented in the sample had recently played leading roles in developing and piloting new administrative programs for their respective computer consortia. Each contracted their systems analysis and program development to separate companies. According to a district respondent, the work was supported by a special Ministry of Education grant. One of the two school districts belonged to an eighteen member consortium. This district invested heavily in the production of a program that processed data for the new provincial Program, Budgeting, and Accounting System. Software development was contracted to a Vancouver company.

A secretary-treasurer who had participated closely in the software production process disclosed that although the original request for proposal contained clearly defined objectives, a detailed description could not be prepared in advance. Some system components remained poorly defined until the program was field tested. Furthermore, many improvements occurred to users only after program

development was underway. A superintendent from another school district concurred:

> It's virtually impossible to sign a (systems development) contract because the costs are so open. You can describe objectives, but, in a situation where new demands are being made, where the system is in flux and something comes down that looks fairly small... When you think of it in terms of programming, of changing the system round, and what your hardware can do – the cost can skyrocket.

Control of development costs was complicated by the involvement of two organizational levels of the public school system: Ministry and school district. The Program, Budgeting, and Accounting System was altered as problems were encountered after its introduction. Further computer program modifications were required to meet these alterations. Programing errors contributed to delays in implementation. Debugging[21] was a process of successive refinements achieved through the interaction of users, systems analysts and programers.

In the first of the two program development cases just cited, the Ministry and the district requested several program changes[22] to accommodate accounting and budgeting system revisions. Program development expenses, including hardware costs, were estimated by the respondent to exceed $130,000. The cost apparently was not recouped by the district. Once the project was complete, neither the district nor the Ministry seems to have assumed ownership in order to

[21] The identification and removal of localized implementation errors – or bugs – from a program or system (Illingworth 1983:99).

[22] Neither the number nor the extent of these program changes were disclosed.

distribute the program free-of-charge, as the following extract from the 1982 Ministry of Education computer acquisition policy stipulates:

> All software acquired under Ministry capital cost sharing arrangements will be owned jointly by the Ministry of Education and the local school district. Districts will make this software freely available to any other school district, upon the request to do so by the Ministry.
>
> (Ministry of Education 1982a:2)

This clause mandates the securing of joint software ownership and implicitly prevents the use of software as a school district revenue source. The policy does not address what should occur when the company retains copyright after development costs have been met by the district and/or the Ministry.

In this instance, the company retained control and sold slightly customized copies to the remaining seventeen consortium members. Considering that development costs had already been fully absorbed, the prices reported to have been charged for these copies seem very high.

8. Processing Capacity Soon Exhausted

With two exceptions, all districts in the sample exhausted the processing power of their computers between eight and eighteen months after installation.[23] As part of their replacement programs, several had either changed

[23] One commercial sector respondent claimed that a competing software company, in the process of writing an accounting application, had exhausted the capacity of a newly introduced computer model widely represented among the province's districts.

models or upgraded their systems to meet additional processing demands, but this expanded capacity was soon expended. One district had connected the recommended maximum of forty terminals to a DEC VAX 11/750 using a bus interface. Employee frustration attended the slow input/output response. The superintendent's surprise with this unanticipated result is evident in the following excerpt:

> There is some concern about the capacity of the thing (computer)... the response time of the thing. And therefore there has been some reluctance to expand. I find this absolutely incredible, that we wouldn't know the capacity of one of these things before we bought it.

The intensive use of the machine for text processing appears to be a major contributing factor. Approval for additional requests for text processing terminals was pending reevaluation of the central office system. The superintendent wanted to fill these requests, but the Ministry prevented the allocation of more district resources to this area.

Several respondents referred to the inflated claims of software and hardware sales representatives. The commercial objective is to achieve a firm sales commitment. Once installed, they anticipate that on-site under capacity problems will be solved by improving the existing system. Upgrading represents a captive market, for it is unlikely that school districts, having recently made a large capital outlay, will be in a financial position to replace the existing unit with a competitor's. Most school districts determine their computer needs with the aid of either full-time employees or consultants. Some respondents argued

that the Ministry of Education should provide this guidance. A superintendent commented:

> It's a shame that (the Ministry) didn't provide assistance in terms of developing guidelines – which from the point of view of an administrator are pretty well impossible to do much about – for determining the best machine for a system such as this... you can't depend upon the industry because they are not very objective.

Another school district pioneered the development of an application for the new program accounting system, only to find that subsequent accounting revisions and program improvements led to a series of modifications which soon exhausted the capacity of the central processor in their Honeywell Level 5. Use of hard disk space exceeded optimal performance, slowing the input/output speed. A third district found that demands associated with program changes outstripped the capacity of its MAI Basic 4. In this case, computer replacement and system upgrading was being considered.

The three machines identified in the preceding discussion – MAI Basic Four, Honeywell Level 5, and DEC VAX 11/750 – were installed in 1982. By the Spring of 1984, each was overloaded. According to the school district informants, improvements to applications, increases in user demand for existing applications, and the development of new applications led to unanticipated heavy processing loads. A weak planning procedure resulted in the selection of computers with processing capacities which could not meet a two-year

horizon.[24]

An analysis of computer purchases over the last four years reveals the following trends. Of the fifty-one districts which received Ministry funding, between 1982 and 1985 inclusive, to acquire administrative computers, twenty-one purchased replacements for existing equipment. The average working life of the equipment was five years, a figure consistent with current industrial and public service expectations. An anticipated five-year expectancy was cited by each district respondent. The average age of the current stock of pre-1982 hardware is approximately five years (Ministry of Education 1982b; correspondence). Machine replacement for the twenty-two districts for the period 1985 to 1988 represents a considerable commitment of future educational capital and an opportunity to prevail over previous policy inadequacies.

9. Flat Organization

A single superintendent asserted that, compared to urban districts with similar enrolments, there were relatively few central office administrators in his district. He described the organizational structure as flat. School level administrative functions were controlled directly rather than through several intermediary management levels.

---

[24] This school district predicament is a public sector example of Wills' finding that "Small and medium-sized Canadian companies rely excessively on suppliers... who have a vested interest in selling particular and perhaps inappropriate product as a source of technical information." (Wills 1979:18).

Table VII
British Columbia School District Central Office Computers By Manufacturer
1982 -- 1985[1]

Manufacturer	Models	Year Purchased and Quantity[2]				Total by Manufacturer
		'82	'83	'84	'85[3]	
Burroughs	1	1				1
Data General	1		1			1
DEC PDP 11/23+	1	1		13	4	18
DEC VAX/11	1		2		1	3
Honeywell		3	2	12	3	20
IBM System 36-5362	1	1			4	5
IBM System 38	1	1				1
MAI	1	2	1	1		4
TOTAL		9	6	26	12	53

Notes:

[1]derived from correspondence and interviews

[2]fiscal year in which Ministry granted funding approval -- not necessarily the year in which computer was purchased

[3]data for fiscal year ending March 31, 1985 complete to February 1, 1985

The administrative structure, however, had evolved largely before his district's 1980 introduction of in-house computers. Despite this observation, and the unusually young cohort of teachers, compared with other districts in the researach sample, as well as the district's predominantly white middle class demography, which represent significant causes, the superintendent maintained that computers had reduced the need for central office administrators and clerical staff. The validity of the superintendent's claim was not appraised. His views are recorded here since they may serve as a potential subject of enquiry for other researchers.

In April, 1982, approximately thirty school districts contracted their EDP requirements to private agencies with remote computing facilities (Ministry of Education 1982b; correspondence). Datatech Systems Limited was the most prominent single vendor, closely followed by the chartered banks. Some districts were connected via terminal to computers at remote locations. As of February, 1985, all districts had in-house computer facilities (correspondence) and none contracted data processing to private agencies.[25]

The expanded use of electronic data processing appeared to meet various practical administrative needs. In the case of word processing, productivity was reported to have increased. More work is being accomplished with either a

[25] To the best of the author's knowledge. In some districts, psychological and achievement testing may represent a limited exception.

very small, or no increase in employee complements. The total number of administrators and clerical support staff was reported by Ministry and district respondents to be falling. The decline is commonly attributed to declining enrolment and lowered educational funding rather than to the impact of computers. There can be little doubt, however, that computers are filling organizational gaps which arise through the Ministry of Education sponsored financial cut-back program of employee termination and attrition.

A tactic of restraining the introduction of administrative computers had served one of the districts under study well. While neighbouring districts forged ahead with computerization, this district waited. The district's secretary-treasurer relished the success of this strategy:

> We did our whole computerization from (a) computer manual plus this payroll that we had done by the Royal Bank off the premises. We converted all that and got a whole accounting system of online budget– and including the hardware, the software, and the consulting, the overtime hours – for eighty-five thousand bucks. That is just phenomenal for a sixty million dollar operation.

The other districts experienced long learning curves in mastering and refining their hardware and software. Some encountered failure. Shrewd administrators from the holdout district analyzed these events with the assistance of a private consultant. According to the secretary-treasurer, many pitfalls were avoided.

10. The 1983 Planning, Programing, and Budgeting System

Several secretary-treasurers identified the 1983 Ministry of Education financial reform as a Planning, Programing and Budgeting System. Most objected to PPBS, pronouncing it largely irrelevant to provincial educational needs. PPBS is viewed as a means of comparing school district financial performance, thereby facilitating reductions in educational expenditure. All secretary-treasurers and some superintendents believed that the system was unworkable. A secretary-treasurer observed:

> They (the Ministry) believe, by the fiscal framework – which is really a modified Planning, Programing, and Budgeting System – they will be able to get a handle on it (comparing school district financial performance). I don't believe that the production of stream quantities of data is going to allow them to do that.

The generation of financial information, although tedious and time consuming, was relatively easy compared with its analysis. Ministry level accountants and planners probably would have encountered difficulties with data analysis in the more financially robust pre-restraint period preceding 1982. The number of Ministry personnel, however, was declining at the same time that new types of PPBS generated information was flowing in increasing quantity into the Ministry. Two outcomes were predicted: 1.) either the information would be ignored, or 2.) management would founder in an inchoate sea of data. The same secretary-treasurer commented on the latter:

> I think they will be overcome, as other jurisdictions have been, with the tremendous amount of

> information that's going to be flown back at them. I think other jurisdictions have found this in Planning, Programing and Budgeting Systems and have modified them extensively or have scratched them.

Ministry officials were not the only ones who might succumb to a data deluge. School district administrators were also experiencing difficulty in deriving meaning from the new reporting system. During the time taken to fully assimilate the information, it became outmoded and irrelevant. Another secretary-treasurer spoke forthrightly about his experience with the district's financial reporting:

> Our management control reports, for example, at one time a person in a couple of hours could get a fairly good grasp on what the financial plans of the district were... Because there were only twenty pages of computer printout, we got an excellent handle on it very quickly. Now we are running for the fiscal framework, a hundred and fifty pages. One individual can no longer get a grasp on that unless he spent his full time monitoring reports, because by the time one assimilated the first set of reports, that month would be out of the way, and the second set would be on the desk.

The school district officials interviewed for this study and those senior public servants studied by Ritter and Cutt (1985) acknowledged a problem which Ministry of Education managerial respondents seemed unwilling to address – large quantities of data make PPBS unworkable.

According to some district respondents, rigid adherence to the fiscal framework would obscure rather than clarify the basis for deciding financial allocations. District resources cannot sustain the increased analytical and input functions required of PPBS. Rigid deadlines leave managers no option than to report or perish. The danger implicit in

this choice is contained in a brief commentary delivered by a superintendent:

> So what it (reporting procedure) really does is encourage expedient behaviour which renders the data less valuable for comparative purposes, or for the original purpose. It compromises the integrity of the fiscal framework.

A situation where middle management questions the content validity of the new financial reporting structure may have been one of the least expected results when Ministry planners introduced PPBS. Financial reporting which once had been meaningful to all levels of the education organization was replaced by a procedure where budgeting formulas changed to meet new exigencies.

District officials viewed PPBS chiefly as a centralized means to achieve financial cutbacks rather than as a means to improve educational performance. A superintendent referred to the fiscal framework's hidden agenda:

> Well, the fiscal framework is simply a PPBS model, instituted in British Columbia a decade after it was introduced in many other places. But inside that fiscal framework, which is nothing but accounting procedure tied to program, inside that were the soldiers of restraint.

There was general recognition that PPBS resulted in increased centralization. Another secretary-treasurer summarized the debate:

> Although there are some people who would plead for the new fiscal framework, that it involves the decentralization of decision-making, I believe the opposite has happened and is happening right now.

Most of the school district respondents similarly assessed the Ministry's financial reform measures.

11. Summary

In a period spanning more than two decades, computers were adopted by all seventy-five British Columbia school districts and a growing number of schools to perform routine administrative tasks. Most of this growth took place during the past five years. The extension of electronic data processing to all levels of the B.C. public school system occurred with a minimum of Ministerial direction. District decisions in many instances took precedence over provincial data processing standards and objectives. The fostering of electronic communication links and data exchanges using existing provincial facilities, an implied objective of the 1982 Ministry of Education computer policy, was not acted upon.

After four years and an estimated six million dollars spent by the Ministry alone,[26] the district systems remain largely isolated from communication and data processing trends sweeping the commercial and public sectors. Nonetheless, demand is increasing among administrative units for improved digital communication and online database access.

Historically, school districts in British Columbia have resisted the centralization of their electronic data processing facilities. Even the quite limited regional centralization proposal of 1969 was not favoured. The 1982

[26] Based on the revised 1983 capital cost sharing formula. For a more detailed discussion, refer to section 6. Capital and Operating Systems under the School District research findings.

computerization project was realized for the most part along a decentralized schema. Fully standardized computer systems would have allowed these systems to be fully integrated in the BCSC provincial digital communications network. Instead, parallel computer communications are contracted to Envoy, a privately operated electronic mail system. The existing school district computer systems do not appear to have been integrated into the electronic mail service. Hardware and software purchases by individual districts have led to increased capital costs. A lack of central coordination has led to school districts unnecessarily repeating the experience of other districts. Some aspects of provincial software development policy apparently are being ignored.

C. SCHOOL

Many school administrators are acquiring useful knowledge as they experience the vicissitudes of rapid change in computer technology. As some expectations remain unfulfilled and new problems arise, alert managers become more adept at implementing microcomputer applications. The pace of learning is rapid. In 1984, a senior secondary school principal offered this perspective on the speed with which administrative microcomputers were introduced into British Columbia schools:

> Three years ago (1981), I don't think there were very many people around in our field that knew what they were looking for.

This was the year in which Harts Systems Limited a field

trial in a second Greater Vancouver school district of its Apple II+ microcomputer program for student management. Since then, some districts have appointed a committee of school administrators to evaluate the field tests of personal computer hardware and software (respondents disclosures). Informal networks, however, may continue to be the main information source for many.

1. Formal Communication of Experiences with Computers

Computer knowledge garnered at personal and organizational cost circulates formally and informally among schools in a school district. Apparently there is no prescribed method of communicating this knowledge to schools in other districts. Trial and error technological adaptation seems the rule, with individual schools often repeating the successes and failures of neighbouring districts. The pace of change contributes to managerial uncertainty. Improved software, more powerful hardware and new informatics services tempt managers to solve old problems with new products. These items are often unproven in the commercial and public sectors and have had little, if any, previous application at the school level. In the absence of a provincial or national testing facility to coordinate and report field trials, the school manager may be unsure of the best purchasing strategy.

A powerful organizational dynamic influences the decision to introduce these products. When more schools acquire

computers, the administrators of schools which do not possess the equipment may be perceived by their colleagues as dilatory. Contemporary administrators function in a society that places a high value on applying technical solutions to social and economic problems. Another strong influence is that an administrator's close association with the introduction of new microprocessor technology may enhance an upwardly mobile career.

2. Types of Computer Services

On a district basis, schools had the largest variation in computer services. The two main categories were the stand-alone microcomputer and the centralized data processing service. Centralized data processing services included two divisions: 1.) district managed, and 2.) commercially managed. Within the two main categories, school-based microcomputers varied widely. Some districts, according to several respondents, stipulated a standard model and manufacturer for all school administrative systems. Others allowed schools considerable latitude in machine selection, a policy that had led to the installation of several incompatible operating systems.

At the service level, each of two districts in the research sample had a network of school terminals connected to a minicomputer located in the central office. One district contracted with a private company. Although in this case, some batch jobs were sent via courier for entry at the

company office, most data was entered through a school keyboard by a full-time data entry employee. In the district managed network, according to district and school informants, all data was transported by courier for entry.

Most school administrators expressed general satisfaction with their EDP systems. One administrator was searching for a microcomputer One-Write[27] accounting program for general office bookkeeping. Another principal had purchased a microcomputer on a Vancouver company's assurance that an off-the-shelf inventory program could be modified for student scheduling. The program did not meet expectations. He had previously encountered similar problems with a privately-owned computer service which offered batch student scheduling. During three years of contracting with this company, programing errors were encountered. The scheduling algorithm did not respond to the school's needs. With deadlines looming, the principal resorted on several occasions to pencil and paper solutions for intractable computer scheduling problems.

3. Student Management Microcomputer Programs

Two Vancouver companies, Columbia Computing Services Limited and Harts Systems Limited, promote microcomputer-based school management programs throughout British Columbia and North America. Student attendance, marks reporting and student scheduling comprise three main elements of these

[27] One-Write is a proprietary accounting package which since this interview has been released in microcomputer form.

programs. In 1984, when most of the interviews for the study were conducted, the Harts program processed records for a maximum of about 1,000 students. This maximum was increased until in 1986 some United States schools were processing records for over 1,500 students (correspondence, March, 1986). Harts runs on an Apple II+ which has a 48K CPU.[28] The Apple II+ uses the DOS operating system. The current price for the complete Harts III is approximately four thousand dollars (correspondence, March 11, 1986). The annual licence in subsequent years is six hundred dollars.

In 1984, Columbia converted its mainframe student management program containing approximately 200,000 lines of code for use on an IBM PC XT compatible system (Company respondent). The PC XT version required 256 K of memory and a ten megabyte hard disk. It handled records for up to 2,000 students (respondent). Today the largest format of this program runs on a PC AT with a 20 megabyte hard disk. The current software price for the 20 megabyte version is approximately six thousand dollars, with a one thousand dollar annual service fee (Company respondent). The program is presently supporting a maximum of 3,500 students in a California secondary school application.

In 1968, Columbia began supplying batch services to British Columbia secondary schools. By 1980, an online

---

[28] Central processing unit (CPU): The arithmetic and logic unit (ALU) and the control unit (CU) and sometimes, but not always, the primary memory. As the functions in a computing system have become more distributed and autonomous, the specification of the CPU has become less significant. (Illingworth 1983:52).

capacity was added. Within two years of the 1982 Harts introduction, Columbia released its own personal computer version, withdrawing the original batch and online services (Company respondent). Microcomputer-based programs sufficiently robust to handle the largest senior secondary enrolment are particularly attractive to school administrators. They return full control over marks, scheduling and attendance to the principal. Comparing the mainframe and microcomputer programs, a respondent stated:

> The bill for running outside timetabling and scheduling had inflated somewhat, and it was costing them fifteen hundred to two thousand dollars a run. And it started to look pretty good to buy a microcomputer for that amount of money, and buy a program for it, and pay off the cost in less than a year for the school. And you could run it as many times as you wanted, and you didn't have to pay for each run.

The microcomputer system gave administrators improved control over scheduling. Principals could ask "What if?" questions without incurring thousand dollar expenditures. There were many indirect costs, however, which added significantly to overall computer expenditures.

4. Transfer of Costs

Moving from a remote data processing service to an in-house personal computer, transfers maintenance and operating costs to the school. For Harts and Columbia, an annual service fee follows the program acquisition charge. The fee includes system updates and an unlimited number of questions relating to software operation. Columbia alone offers a toll-free telephone number. Hardware costs including

computer, printer, hard disk drive and, in some instances a tape drive and optical mark reader, may total over twenty-thousand dollars. Although many school administrators regard these as one-time expenditures, if the recent example of school district computer acquisitions is a reliable guide, schools may on average expect to replace their hardware once every five years (*see* Research Findings, B. School District 8. Processing Capacity Soon Exhausted).

Responsibility for the operational failure of new microcomputer programs is not clear. Is system failure due to a fault of the operator, hardware, or software? Administrators tend initially to attribute operating problems to the software because they recognize that the programs are often relatively young and unproven. While addressing the difficulty which schools had in establishing responsibility, a senior secondary vice-principal commented:

> They are obviously servicing the pilot project very well because they want to guarantee its success. But I am not sure what happens when that... expires. The concern I have already is, for example, if there is a hardware failure, Columbia has no responsibility in that. Their response is: "Well, phone wherever you bought it." The person's (hardware representative) typical response will be: "It sounds to me like it's a programing flaw..." So you end up with the school being individually responsible for maintaining this equipment.

Currently, software support by the two vendors appears satisfactory since the respondents did not cite any problems. Administrators tacitly acknowledged that some errors will be encountered due to program immaturity. School managers generally participate actively in program debugging, advising

programers by telephone of the problems encountered.

When school-based personal computer costs, for example system security, data archiving, data entry and annual service and maintenance are totalled, personal computers may prove more expensive than either the centralized batch or online options. The only area where microcomputers appear to have a clear advantage is in the immediacy of response. Delays which arise from backlogs associated with cyclical overloads and central system failures are usually not encountered in the microcomputer environment.

5. Indirect Labour Costs

Hidden labour costs are recognized by school managers as a significant factor in operating administrative microcomputers. Depending on the school, data entry and retrieval tasks are assigned to vice-principals, teachers, counsellors, clerks, and students. Many of these costs do not appear to be captured by either school-site bookkeeping or the provincial organization's new budgeting system. Although job responsibilities are often arbitrarily redefined to encompass school-based computer tasks, these changes appear to be only infrequently reflected in official job descriptions. Comparing the labour charges of commercial batch contracts with those of microcomputer processing, a senior secondary school principal remarked:

> The costs (of microcomputers) are less. There was a bit of a cost thing there, going outside. Mind you, there's time here with counsellors and clerical staff plugging in and putting all the stuff into the

> computer, but the cost thing, turn-around time and also the expertise that the (microcomputer programing) companies do not have. So we really, other than the time factor that we're adding, you know, bags of- a fair amount of additional time right now. But in the long run, I think it's going to be better all the way round.

Some vice-principals found themselves assigned not only the responsibility of maintaining the school's personal computer, but also performing the task of keyboard data entry. These new responsibilities departed significantly from the exclusively administrative orientation of the vice-principal.

In the midst of restraint, some local purchasing discretion remains. Principals and vice-principals indicate that avenues exist for obtaining computer products which do not involve district office approval. A senior secondary principal described the redeployment of a microcomputer:

> With the hardware, with the Apple, we managed to not have to put any money out for that at all. Some schools have had to go and buy the hardware, but in this case, we got it in the school for- It's being used for Career Choice (a student counseling project), well, its being used for the timetable sort of thing. We've got a dual purpose thing.

On the tape recorded transcript, the principal's voice and phrasing convey uncertainty. He had unwittingly stumbled on a subject which from his vantage may have been better ignored. The microcomputer was acquired for the benefit of students who sought career counselling, but was reassigned to recording student attendance. Since attendance for the school's approximately one thousand students is taken every period, there is only a slender opportunity for students to

access the machine for career counseling.

With only one exception, a shortage of data entry personnel was observed. Financial cutbacks had reduced the school office staff in the sample by as much as fifty percent, according to some respondents. In some cases, office workers belonged to the Canadian Union of Public Employees (CUPE). School administrators seemed aware that CUPE is in the vanguard of those Canadian organizations responding to the employment effects of microprocessors. One strategy for overcoming employee reluctance, elicited from school managers, is for the administrator to introduce the machines gradually, while never insisting on their use. This strategy was outlined by a senior secondary school principal:

> When word processing first came... there was considerable anxiety about what this would do to the stenographic workpool. There were union contracts... People felt, I think, somewhat threatened. So, actually using word processing in administration in offices is something that has come very, very slowly.

Secretaries and clerks in the target districts for the study were slowly adopting word processors. Only two principals cited labour contracts as obstructions to the implementation of microprocessor technology. According to some respondents, once office staff had operated these machines, they demanded word processors for their own use, but strongly resisted job reassignment to data entry status.

None of the principals interviewed had a computer terminal or a personal computer in their own office. With only a single exception, all denied knowing how to operate a

computer. The exception, a principal, said that he had never used the school's administrative microcomputer although he had operated a PC in his home. Principals relied on clerical staff, junior administrators and counselors to produce computer-based reports and perform data entry work. Some administrators noted the important role computer generated student attendance, performance and counseling reports played in briefing parents.

The demands of data processing seldom result in a new school-level employment category. Most EDP tasks are absorbed within existing categories, apparently without any necessity to change job descriptions. Typically, school staff already carry a heavier work load due to reductions in office personnel performed within the mandate of public sector restraint. Clerical staff time was fully committed, in some cases even overextended. Under these straitened circumstances, data entry tasks are assigned to vice-principals, counsellors and teachers. One senior secondary principal expanded favourably on his vice-principal's new chores:

> The vice-principal is a first-class expert in computers, and so he has taken upon himself, with the help of the counsellors, to really start from square one and put the timetable together. It's an Apple, and they are making it all happen. We bought the Harts system which is a thirty-six hundred dollar item...

Vice-principals had a different perspective on their new assignments. They objected strongly to what one principal called, "donkey-work." To meet scheduling and reporting

deadlines, some vice-principals worked overtime. A senior secondary vice-principal complained bitterly about his computer responsibilities:

> In the junior high, I used to sit-down and key-in daily attendance. Now, is that what an administrator of a school should be doing? Is that my job function?
>
> It's almost like asking the captain of the ship, and saying, "Well, you paint the side of the hold, fellah." I mean, that is not in my opinion where we're at, but sometimes, because of your position, you're the one who can come in on Saturday and Sunday to do it. I mean, if you find out how many times I've opened up this school on a Saturday or Sunday in the last three months to work on the timetable because the work is not being done by our clerical help...

This administrator spoke at length about his frustration. His assertion that computer-related responsibilities represent a misapplication of resources are credible, but he seems to have authored his own problem. Confronted with public sector restraint, and the high probabililty of either being made redundant or reassigned to a full-time teaching position, computer involvement presented an opportunity to consolidate his hold on the vice-principalship.

There was wide recognition that microcomputer data entry costs were absorbed in ways which diverted resources from officially approved budget categories. With centrally operated systems, accounting for the actual operating costs is simpler, since these are included in the contract price. A senior secondary principal reflected:

> Well, someone at Columbia, or it was in California, or wherever, Cogito, wherever it was done— Someone was paid there, which we were paying for to insert all that information into the computer. Well, now we're doing it in the building here. Someone has to

> do it in the building. And I bet you, you know, if you looked around in different schools, you might find anywhere from the vice-principals to timetable committees, to department heads, to counsellors... You know, many of the people in the clerical staff are not trained... Nevertheless, you're taking money away from something else... It takes a fair amount, and when that's happening other things aren't being done.

A senior secondary school vice-principal estimated that it took forty hours for a skilled typist to enter course and student data each term. Enrolment in this school was approximately 950. The vice-principal commented:

> If you want to put in there (timetable program) eight courses for each student, there is a week's work for one typist working eight hours a day (at) data entry.

Several school managers agreed that considerable time would be saved if student records were entered into a computer data base in grade one, to accompany the student through junior and senior secondary school.

One respondent surmised that since the appearance of microcomputer attendance programs, teachers were required to perform less clerical work. The school district department manager noted:

> What is happening there (schools) is you've got a shift; instead of the teachers' time filling in the registers— (it's) shifting now to the secretary. So we have to look at it. Which is more economical?

Most of a teacher's time is absorbed in reading the roll and noting absentees, manual tasks which are still required by a computer attendance program. The amount of time saved, if any, is probably quite small. As a soon to be cited example of teacher resistance to computerized attendance will

demonstrate, some teachers remain unconvinced of its labour-saving potential.

As a last resort, students are drafted to complete computer related tasks. A department coordinator reported that his computer science clubs had laboured on an attendance project. The clubs typed computer cards for each student and completed other clerical duties. The respondent recounted:

> I had my computer science and computer clubs type-up or printout a computer card for every student in the school, and that was eleven hundred at that time.

Despite the voluntary commitment made by teacher and students the attendance program failed. Some teachers strongly objected to computerized attendance records. The coordinator summarized the events which led to the project's abandonment:

> And I made another presentation to the staff, and we had a couple of dry runs with it. And there was such a lack of cooperation among the staff – and its people make the system run even if the computer is being used – that I gave up on it, after several dry runs, because of mutilation of the computer cards, because of (the) inability to follow, maybe, five simple instructions on how to send the cards down to the office.

Two issues are presented in this account. First is the question of the appropriateness of students volunteering their time from their extracurricular studies to perform clerical work usually done by employees. Second is the problem of teacher resistance to computerized attendance.

School managers have contributed to the debugging and improvement of microcomputer school administration programs

developed by Harts, Columbia and other companies. During the twelve- to twenty-four months of operation following their introduction, these programs require considerable user feedback. One company targeted several British Columbia schools for testing before launching its product on the marketplace. According to three respondents, including a representative of the company, these schools were not compensated for the contribution their staff and administrators made toward program improvement. Non-monetary motivations, however, may make the voluntary effort a satisfying one for school administrators. A senior secondary vice-principal spoke glowingly of his involvement:

> I think there are a number of administrators, perhaps myself and four others, who gave them a lot of good suggestions, and they have incorporated a lot of these into their timetable (program)... So (product name deleted) has really improved greatly.

Satisfaction at having completed a job well motivated this administrator. Close involvement in a project outside the bureaucratic routine is welcomed as a challenge in which latent talents can be exercised.

6. Data Retrieval

Many junior secondary schools which use Apple II+ microcomputers to record student attendance have found data retrieval time-consuming. In one case, twenty floppy disks were loaded before a student's yearly attendance was generated. Slow data-retrieval nullified the machine's advantages. A department manager recalled a conversation he had

with a principal on this subject:

> He indicated that the things they liked about Harts were the nearness of the information. It was right there at their finger tips. What they didn't like is the slow processing speed, and the disk handling is ridiculous.

Slow processing speed, frequent disk handling, and the need to support each floppy disk with several floppy disk copies on a daily basis was mentioned by several school administrators. Copies of the attendance data base were printed regularly on paper (hard copies). Some vice-principals stored backup floppy disks at home to reduce the chance of data loss through fire, theft and tampering. A senior secondary school vice-principal addressed this archival question:

> When you start-out with Harts, you end-up with four diskettes, but when the year finishes, you end-up with about twenty-two floppy disks... I mean, I run four backups on a daily system. So the most I would lose is a day's documentation.

Some of these problems will be partly solved or completely eliminated as new products are introduced. Harts and Columbia continue to improve their products, especially in processing speed. Hard disk prices have fallen considerably over the last three years. Columbia's microcomputer school management program depends primarily on hard disk storage. Mass market digital tape drives, announced by manufacturers, but not yet delivered, will probably end the labour-intensive handling of floppy disks.

Important problems remain: confidentiality, security of student records, and the danger that students will become irrevocably typecast by education and social systems which

increasingly store and manipulate large quantities of personal information. Several school administrators proposed that computer-based records accompany students from kindergarten through senior secondary. As a consequence, the burden of data entry at each level would be eliminated. Other dimensions could benefit the student. Medical knowledge (one microcomputer program records health problems) could improve student learning and assist with health emergencies.[29] An unambiguous synopsis of student interests and learning profiles would aid the teacher-student relationship, assuming that classes are small, and the teacher has time to consult the data base. Given the recent British Columbia trend toward larger class size, most teachers have less time to utilize such a potentially valuable resource.

No administrators objected to computerized preparation of student report cards. One senior secondary principal initially opposed them, but over a five-to-six year period, he came to accept their efficiency; he observed:

> No, I had strong, in the other schools, anyway, strong objections to computer reporting. I can't say the parents (had strong objections). You get one or two parents who sort of, who comment. But with the computer reporting you can always have—your hundred and twenty-ninth comment can be, "See comment." And so you can always leave it out for somebody to do something in the handwritten form, if they so wish.

Computerized report cards are here to stay. Missing is evidence that this new technology is being fully exploited in

---

[29] During a student management program demonstration, a sales representative clearly implied that a database demographic category would be used by some United States schools to identify students by race.

the service of students and parents. Current computer-based reporting of student progress exists within the 'ten words or less comment per subject' constraint inherited from preceding manual reporting procedures. Supported by a text processing program similar to that established in 1968 by the Prime Minister's Office to answer mail (Westell 1970: 329) and improved over the years, computerized student report cards could convey substantial additional information regarding individual student progress.

Several principals disclosed that the use of computers for individually addressed mass mailings to parents contributed to improved community relations. Prior to microcomputers, distributing personally addressed letters was not financially feasible for most schools. No community relations problems were cited regarding computer preparation of student reports.

7. Preference for District Office Star Network

A single exception was noted to the preference school managers expressed for school-based microcomputer performance of data processing tasks. This principal's twenty-year managerial career in education and his long involvement with administrative computers make his remarks worthy of elaboration. Strong satisfaction was expressed with the district's online and batch processing computer service. The centralized data entry service is especially advantageous because its features are not duplicated in a

microcomputer processing environment. Centralized data processing enabled the most cost-effective use of labour. Additional personnel were hired on short notice and extra shifts instituted to meet cyclical peaks in data-entry demands. During these peaks, data was dispatched by courier and results returned the following day. At best, a large secondary school can afford only a single data-entry employee, indeed, only one senior secondary school in the sample actually employed a full-time terminal operator. In periods of heavy demand, such as student grade reporting, deadlines may not be met in a school-based microcomputer environment. Keeping the keypunch operator productively employed during periods of low demand poses an additional problem.

This principal favoured a star network[30] with school-based terminals. He had participated in the district's first administrative foray into computer applications in the mid-1960's when it was the first in British Columbia to apply computers to administrative tasks. The senior secondary school principal's experience served as an historical precursor to the contemporary microcomputer experience of other principals:

> IBM wouldn't listen to us (about writing the time-table program); the local people thought that it was simply another bookkeeping process. And we found out in short order that they were in a hell of a mess. And they sent two of their heavy-duty people

[30] A star network topology consists of a single hub node with various terminal nodes connected to the hub. The terminal nodes do not interconnect directly (Illingworth 1983:240).

in to cleanup their reputation and the problem. This concern for the success of its applications, irrespective of customer size, contributed to IBM's reputation as a highly responsive corporation. In turn, this responsiveness helps to establish a higher standard of reliability for business activities involving all aspects of the computer marketplace.

8. Field Testing

Most districts field tested their microcomputers, but none of the schools visited had participated in the trials. Some principals referred to field trials underway in their districts. One of the largest districts was particularly advanced. A committee consisting of secondary school principals coordinated field testing of personal computers and software. Several schools conducted rotating trials. Their assessments were for internal use and did not appear to be made widely available to other districts. Some elementary schools were also conducting field trials.

To an extent, the conduct of field trials was a school district response to the unfortunate experiences of some school administrators. One principal described the acquisition of a computer and program which proved to be a financial loss. The software, originally designed for warehouse inventory, never functioned properly despite repeated modifications by the Vancouver vendor. The decision to purchase an untried program was taken at the principal's initiative.

Since this failure, the district has tightly coordinated microcomputer acquisitions by school administrators.[31]

9. Organizational Conflict

As fresh applications are found for student data, the education organization may stray onto alien territory. An example of this conflict was uncovered during this study. School and school district organizations had clashed with the city Health Department. According to the district official's disclosure, a principal, during the course of extracting information from the student database, revealed that a group of his students required eye examinations. This list was dispatched to the health authorities. Here is the school district department manager's description of the succeeding events:

> One of them (principals) actually caused a minor controversy with the Health Department because this person put the pupil health records on the system and then did a search and pulled out all the students who had never been screened for eye examinations. And then (he) sent a memo to the school health nurse saying, "These students haven't been screened, please screen them." She got upset and went to the Health Board, and everything, saying that was her responsibility, the principal shouldn't be intruding in her area. But to the principal's point of view, this was sort of dead information on

[31] The problem of overly enthusiastic administrators continues. An advertisement was placed by the Prince Rupert School District (#52) for "programs for the Macintosh microcomputer on the following subjects: School District Operating Budgets, Teacher Personnel Data." (BCSTA 1984:2). The advertisement appeared only six months after the Macintosh was introduced; general business applications were rare. By November, 1985 the district had not located a single administrative programing application suitable for school districts. At last report, the 256K RAM machine was being used as a word processor.

> paper cards, and what it did was suddenly, by just poking around on the computer, this was pulling out information in new and unusual ways... which gave him a different perspective on his students.

A manual examination of the cards would have produced the same information. What is new, however, is the speed with which the relevant data was extracted. Enter a few simple instructions, wait only a few minutes while the machine retrieves and prints the information, and one has a list which would have taken several hours to produce – hours not easily found in a school experiencing staff and teacher cutbacks.

10. Computers and Centralization

Although some school administrators said that school-based accounting procedures remained essentially unchanged by the Ministry of Education's financial reform, most thought that the school system had become more centralized. Some addressed the connection between computers and centralization at the school district level. A junior secondary school principal phrased the issue:

> The computer is only the machine that does the actual work, so that is no problem. In fact, I think if we can save a lot of paper work going across my desk, that's great. It is the decisions behind the computer that bother me.

He explained that these decisions focused on achieving financial cutbacks and increasing Ministry control. Another junior secondary principal delineated the problem:

> I think if they can work that (district computer compatibility with the Ministry) through, they have the computer system, they have all the districts

> working the same way, and it will all flow back and forth. That is control to a great extent, and there is no doubt about it that I think the whole system is set up to be computerized and heavily controlled.

11. Summary

The public school system appears to be incurring large additional costs as student management programs, previously run on a fee-for-service basis, are now leased and operated on school-based microcomputers. Many costs associated with these microcomputers, for instance data entry and information retrieval, seem not to be captured by either existing school-site or province-wide accounting practices. Until those costs are fully tallied, the service and financial benefits of district computer networks connecting schools cannot be compared with those of stand-alone microcomputers. Some districts are conducting field trials, but there are no means for distributing results to schools throughout the province.

Principals often delegated EDP tasks to vice-principals, counselors, teachers and clerks. Several vice-principals reported that their managerial roles had been significantly changed by computers. They routinely performed data entry and retrieval tasks, occasionally on an overtime basis. The vice-principals strongly objected to this clerical responsibility. No administrators were found to have computers in their personal offices.

D. BRITISH COLUMBIA SYSTEMS CORPORATION

One of the strongest influences on the development of computer services within the Ministry of Education was the provincial government's decision to centralize electronic data processing under the aegis of the British Columbia Systems Corporation (BCSC). The Corporation coordinates information activities thoughout the provincial government, while the financial and expenditure management of information systems is the function of the Treasury Board. The *System Act* establishing the Corporation was proclaimed on September 1, 1977 (British Columbia 1978). Colleges and boards of school trustees came under the data processing authority of BCSC. By March 31, 1978, the Corporation had consolidated all financial and other data processing work for seventeen ministries and most Crown corporations (Turnbull 1979:4).

The decision to consolidate was preceded by a 1976 confidential study of government electronic data processing, including the Ministry of Education, prepared for Cabinet by the management consulting firm of Woods Gordon. The report warned that were ministries allowed to "continue building in-house computer empires, manpower savings that might result from office automation could be swallowed by programs intended to take up the slack" (Globe & Mail 1984:BC1). Premier William R. Bennett reiterated this view in an October, 1976 address, "all computing resources of staff and equipment have been uncoordinated and scattered throughout

many departments... this approach has resulted in many problems related to top-level neglect, lack of policy, and lack of equipment and qualified staff." (Leiren 1976:76).

Prior to 1977, there were seven provincial government computer centres which together followed three mutually exclusive technologial directions (BCSC 1980-81:4). The Ministry of Education computer was not one of these centres (correspondence, May, 1985). The three operating systems included one designed by Honeywell and two designed by International Business Machines Corporation (BCSC 1980-81: 12). According to BCSC, each systems architecture required a separate technical support staff, a factor which led to significantly increased costs, while limiting productivity improvements and personnel utilization. Of the two IBM access systems, Virtual Storage (VS) and VSI, the Corporation chose VS.[32] The Woods Gordon consultants were also concerned that individual Ministries would entrap themselves, thereby reducing their ability to combine and integrate computer applications (BCSC 1980-81:5). With rapid accessing of shared databanks a primary objective of government and commerce, electronic communication among provincial ministries, and between ministries and non-governmental agencies received renewed importance.[33]

---

[32] Virtual Storage is an access method suitable for files with sequential or relative organization on direct-storage devices. The whole file is mapped into virtual memory so that records can be accessed at random using a calculated virtual address (Illingworth 1983:387).

[33] According to William McMinn, principal author of the 1976 Woods Gordon report, "a central computer facility would hold annual increases in data processing costs to ten percent,

1. Standardization On SNA

By 1982, BCSC at considerable cost had converted all three systems architectures to a contemporary IBM VS design (correspondence May, 1985).[34] That IBM competed with companies which manufactured IBM plug-compatible products was deemed the chief reason for standardizing on their operating system. The Corporation anticipated that competition would result in these products being delivered either at less cost or with a better design than those of a manufacturer which did not have plug-compatible competition (1980-81:11). In practice, contracts for mainframes and most disk drives were let without competitive bidding. IBM has been the main recipient of these three-to-five-year contracts (BCSC 1982-83:12).[35] The objective of a single architecture was attained in late 1981 (1979-80:6).

IBM's successful *de facto* international standard in computer communications networks – the Systems Network Architecture (SNA) – was of considerable consequence to a Corporation confronted with the complexities of rapidly installing and supporting a data processing network that would unite government and public agencies across the province (BCSC 1981-82:13). SNA is the description of the

---

[33](cont'd) versus the twenty to thirty percent increase experienced... between 1972-75." (Globe & Mail 1984:BC1).

[34] Conversion of Honeywell 6066 applications took 268 people who logged in excess of 100,000 hours (BCSC 1981-82:12). The Minister of Finance estimated the cost to be six million dollars (Hansard 1981b:4737).

[35] BCSC purchases of IBM 3081D and IBM 3081K processors are examples.

logical structure, formats, protocols, and operational sequences for transmitting information units through, and controlling the configuration and operation of networks (IBM 1985:58). This interface is the foundation of IBM's unified teleprocessing strategy (Rutledge 1981:2).

Open Systems Interconnect (OSI), a seven layered reference model designed by International Standards Organization, is SNA's major competitor. OSI connects dissimilar systems, while SNA is the basis for a coherent product offering. In 1985, under the direction of the European Parliament, IBM produced two pieces of software that provide limited bridges between SNA and OSI (New Scientist 1985:34). Computer users will have to look elsewhere for software transfer, such as electronic mail from OSI to SNA networks (1985:34). The more fully a computer can participate in an IBM data network, the more valuable it is to users and vendors (Verity 1985:93).

SNA was announced in 1974 and network services based on the SNA CCITT X.25 packet network standard first appeared in 1977 (Rutledge 1981:27).[36] By June 1979, differences in CCITT X.25 implementation had resulted in increased cost and had retarded the availability of equipment to support packet networks (1981:34). Although reunification of X.25 was achieved by 1982, continuing changes to complex SNA protocols make the shifting shape of this interface paramount in the planning of large data processing agencies such

[36] All school district minis and mainframes in the research sample complied with the CCITT X.25 protocol.

as BCSC and the British Columbia public school system. A version of the Ministry of Education policy circulated in 1983 refers specifically to the role of the SNA/SDLC protocol in the provincial government's communication network (Ministry of Education 1983b:14). Synchronous Data Link Control (SDLC) is a discipline for connecting network components, using telecommunication links (IBM 1985:12). On SDLC a number of messages flow in one direction before receiving a response, thereby increasing the data carried on a link.

2. Ministry of Education Included in Centralized Service

Shortly after the 1977 proclamation of the *System Act*, responsibility for Ministry of Education computer staff was transferred to BCSC. Ministry programers and analysts were relocated to positions outside the public service. The transfer produced many months of user service problems. Deputy Minister of Education, Dr. Walter Hardwick, was among the first public servants to openly express reservations about the Corporation: "the idea of consolidating operations might be sound, but the problems of bureaucracy always seem to develop when the policies are carried out." (Danylchuk 1979:9). His comments reflected a widely held public service view.

Other public servants, anonymously conveying their criticisms to the news media, cited high rate structures, slow terminal response time, lost data and lengthy processor downtime. In 1977, a committee of deputy ministers drawn

from the Ministries of Finance, Human Resources, Health, Forests, and Environment, the major data processing consumers, began to meet informally to lend an authoritative voice to the growing disaffection with centralized data processing. The Ministry of Education may have been an indirect participant. On October 31, 1979, at the request of Evan Wolfe, Minister of Finance, the committee was formally established as the Users Review Committee (Hansard 1981c: 6093), and later integrated into the Corporation. A year earlier, on October 15, 1978, the *Initial Report of the Inter-ministerial Committee on the Electronic Data Processing Services* was submitted in third draft, again at the request of the Minister (Hansard 1979a:329). The report recommends:

1. The minister be given authority to effectively control the systems and electronic data programming functions required to deliver their services.

2. Each ministry be given the capability and authority for selecting computer service best suited to its needs.

3. To improve communications, to reduce learning time and errors and to improve the service, it is essential that a minimum number of maintenance programmers be permanently available to the ministries. At the moment they only exist within the Systems Corporation. The development and operation of a good EDP system is dependent upon EDP staff, which understands and associates with the goals of user ministries.

4. The interministerial committee on data processing be the vehicle whereby all ministries can exert the necessary level of influence upon decisions which affect them.

(Hansard 1979a:330)

Cabinet did not act on these recommendations. Implementing

them would have returned control to the ministries, reversing the already well advanced consolidation process.

3. School District Response

School district response was mixed. At least two school boards, Coquitlam and Nanaimo, sought exclusion from the *System Act* (Hansard 1977:4582). Coquitlam School Board motioned that the Minister of Education be asked to have:

> School Districts removed from the provisions of Bill 44 - Systems Act, thereby allowing Boards the opportunity to find economies in providing data processing services.
> [sic] (Coquitlam 1977:8)

Nanaimo petitioned the Minister of Finance for the right to continue their EDP service contract with a local credit union. The Minister of Finance assured the districts that they "are still going to be able to use the current services that they employ. We merely want to be able to vet their plans from time to time." (Hansard 1977:4583). The Minister also indicated that several boards had requests before the systems group to use their terminals and services (1977: 4584).

4. BCSC Prevails

By 1980, BCSC managers prevailed over many of the start-up problems. For several years, costs to clients had declined, falling by ten percent in 1980 (Table III). User access time and processing speed had improved. A 1980 Price Waterhouse Associates study confirmed that the strategy of

combining in-house systems development with sub-contracting some software work to private companies had resulted in rates to clients below those charged by private data processing companies (BCSC 1980-81:6; Kesselman 1984:14). The delivery of an executive management information system[37] to the Ministry of Health for use by the Minister and his planning department was proof that BCSC could produce a software application of considerable complexity (Appendix D).

At present, the data processing configuration which BCSC supplies to the Ministry of Education includes online and batch processing of a time-shared computer located at a remote Corporation-controlled site. Access to the computer is achieved via six ministry-based data entry terminals (Ministry Annual Report 1982-83:57). There is online editing and batch transmission to master files on the BCSC host.

5. Corporate Control of Microcomputers

Since 1977, Ministry of Education computer expenditures have been closely monitored under a government-wide policy initiated by Treasury to ensure that computer purchases comply with BCSC policy. All microcomputer purchases, excepting word processors, were channelled through the Corporation (Ministry respondent). It appears that in the founding years of the Corporation one of the primary objectives of this policy was to restrict microcomputer use.

[37] An automated advisory system composed of management rules which specify actions that can be taken if certain conditions occur.

Public servants were thus compelled to utilize the centralized computing service. To avoid this constraint, some ministries were reported to have modified their word processors by adding memory boards that made them capable of running off-the-shelf financial, statistical and spread sheet programs (Danylchuk 1983a:B7). For accounting purposes, spare parts were recorded as additions to office inventories (1983a:B7). In order to control the rising use of microcomputers, BCSC attempted in 1983 to gain jurisdiction over word processor requisitions. However, as early as 1981, the Corporation recognized the larger role which microcomputers and minicomputers were to play in government processing (BCSC 1981-82:4).

Personal computers appear to have been deemed a threat to the financial success of the mainframe operation. BCSC was committed to using mainframes for as many applications as possible. Over the short-term, microcomputers could not be controlled to the same extent. Indeed, some administrative respondents at the Ministry level avowed that personal computers could not be centrally controlled under any circumstance.

During fiscal year 1982-83, Treasury Board policy was changed to permit ministries to purchase personal computers if their use achieved economies outlined in the Public Sector Restraint Act – in short, if they reduced the number of employees (Ministry respondent). By 1984, approval for personal computers and word processors appeared routine.

For only large purchases, did Treasury Board require a formal business case:

> Ministries must make a submission to the Treasury Board for any systems acquisitions or development expenditure which exceeds $100,000 and this submission must be accompanied by a business case showing costs and benefits over five years. Each submission is analyzed by Treasury Board Staff within the Ministry of Finance. The determination of whether a computer application should be run on a mainframe, mini or micro computer is based upon the related costs and benefits contained in the business case.
> (correspondence, December, 1984)

6. Treasury Board Attempts to Sell BCSC

On August 31st 1983, the Government of British Columbia abruptly announced that the B.C. Systems Corporation was for sale (BCSC 1983-84:18). This action coincided with the second year of financial restraint and the reintroduction of compulsory provincial examinations for all grade twelve students. BCSC with 1983 revenues of over sixty-four million dollars (Table VIII page 168) was the third largest EDP agency in Canada (Kesselman 1984:14).

Several developments may have precipitated Cabinet's decision to unload the Corporation. First, revenue only modestly exceeded expenses (Table VIII). But in four years, revenues in the form of direct charges to the provincial government had almost doubled from the 1980 total of forty million dollars to the sum of seventy-five million dollars in 1984. This rapid escalation in total processing and development charges not only contradicted the government's 1976 prediction that centralized data processing would hold

Table VIII
British Columbia Systems Corporation
Financial Performance
1979–1984[1]
(in dollars)

Year[2]	Revenue	Expenses	Net Income
1979	29,115,000	26,886,000	2,229,000
1980	40,173,000	39,936,000	237,000
1981	49,103,000	47,581,000	1,522,000
1982	57,928,000	55,252,000	2,676,000
1983	64,984,000	64,964,000	20,000
1984	75,586,000	77,238,000	(1,417,000)[3]
1985	72,689,000	73,722,000	(1,427,000)[3]

Notes:

[1] Source: British Columbia Systems Corporation Annual Reports

[2] Year ending March 31

[3] Deficit

annual increases to approximately ten percent, but also came at a time of provincial revenue shortfalls and mounting fiscal restraint. Second, the Deputy Minister of Finance had cancelled the Corporation's development of "a comprehensive integrated government-wide network of financial systems." finding that it was too complex and costly (Ritter & Cutt 1985:73). Two years of systems development effort and several million dollars were funnelled into the project. Third, considerable latent opposition to BCSC remained within public service ranks – a situation not assuaged by BCSC's pre-1982 attempts to restrict microcomputer use. Fourth, the decision to pursue markets within untapped sectors of the public service, such as school districts (Globe & Mail 1984), swelled the number of disgruntled users with a potentially vocal political opposition: boards of school trustees.

The proposed sale created considerable uncertainty for most of the Corporation's employees. Some activities were disrupted to the point of paralysis. For many line workers termination of employment seemed imminent. Of the Corporation's 540 employees, 350 personnel reorganized themselves into a worker-owned cooperative, Hi Tech Staff Ventures Limited (Danylchuk 1983c:B8). Hi Tech submitted one of the three bids received to purchase BCSC assets.

Opposition to the sale was widespread among the province's business sector; most commercial software developers believed that private acquisition by a single company

would lead to their exclusion from lucrative program and systems analysis contracts (Danylchuk 1983b:A3). For the years 1980 to 1982 inclusive, annual spending in the commercial sector averaged ten million dollars (BCSC 1980-81:6 & 1981-82:1). The software developers' revised position departed from their initial 1977 condemnation of the government for centralizing data processing (Vancouver Sun 1977: 44; Boyle 1978:D8).

After soliciting bids for seven months, the provincial government rejected all offers. Ownership of most assets such as buildings, hardware and software remained with the BCSC. The federal government had a direct interest in the Corporation's survival; thirty-seven million dollars was loaned to BCSC from the Canada Pension Plan to finance construction of a new headquarters (Kepneth Bell 1983:17). In the reorganization which followed, some systems analysts and programers were stationed with ministries on a semi-permanent basis. The number and value of system development contracts let to the private sector was expected to increase to fifteen million dollars (Danylchuck 1984a:7). Despite a first-time 1984 loss of 1.4 million dollars, BCSC remained undaunted. The 6,000 workstations on networks serving British Columbia's 35,000 public servants were growing by fifty percent each year (Greer 1985:4). This represents a ratio of one workstation for every six employees. The work stations are supported by two mainframes and thirty medium-sized computers from four different manufacturers (1985:4).

With the provincial government's strong reliance on systems technology, the future of centralized data processing is assured.

7. Summary

The British Columbia Systems Corporation guided the provincial government through a demanding rationalization of its informatics system. The process was costly, but the results, an improved communications system, a means of tracking system development costs, and the guidance of specialists are indispensable to a large public service organization. As BCSC experience continues to accumulate, knowledge about system development is available to all government offices. Corporate relationships with the provincial public school organization and the Ministry of Education have been mixed. The removal of Ministry expertise was not compensated by a vigorous BCSC involvement in product assessment and development of informatics standards for schools and school districts.

E. Recapitulation

The computer's capacity to store and manipulate large quantities of information catalyzes many changes currently sweeping Canadian society. Computer applications to the management of British Columbia's public school system represent a small but significant contribution to this national trend. Beginning in 1961 when the Ministry of Education

acquired its first computer and continuing to 1985 when all school districts and many schools had acquired them, centralization has been the most significant administrative impact. Although in 1982 the school districts prevailed in a long-standing conflict with the Ministry over who determines the type of computer installation, the Ministry retained the right to specify their principal use.

The aim of the 1982-84 implementation of data processing for the Planning Programing, and Budgeting System – the largest computerized project undertaken by the Ministry – was to attain firm centralized control over expenditures. This objective was achieved. There followed a decline in school board autonomy and, for all administrators subordinate to the Ministry, more restrictions on personal initiative.

Few senior and middle management administrators have had their work directly affected by computers. Only at the most junior ranks do administrators regularly operate a computer. Data and word processing for the majority of educational managers is performed by clerks and secretaries.

The 1982 British Columbia school district computer project resulted in one of the most operationally restricted systems of its size in Canada. Simple, single theme explanations are elusive. Other provincial educational authorities, for instance Quebec's, had many years of success experience with standardized computers and centrally developed software. Two major reports in as many decades recommended

that the B.C. Ministry adopt a strong formative role in EDP policies. During the planning stage of the 1982 district policy, an emphasis on electronic networks and digital communications was evident in not only the Canadian private sector, but also the British Columbia Systems Corporation, the provincial government's data processing agency.

For at least a decade, insufficient expertise has hindered Ministry policy on informatics development. In contrast, by 1984 at least four B.C. school districts employed full-time computer managers who had either systems analysis or programing backgounds. In recent years the Ministry had no permanent employee with similar experience – until 1984 when BCSC stationed personnel in each ministry. Additional explanations for the policy results reside in: 1) the politically charged subject data processing became for the public service, 2) fiscal restraint which plunged those responsible for Ministry computer policy into a declining zero sum game[38] of cutback management, 3.) inter-agency rivalry over data processing that pitted school districts, the Ministry and BCSC against each other and, not least, 4.) lobbying by computer and software companies which led to the implementation of a fragmented master plan.

[38] A zero sum game is one in which the cumulative winnings equal the cumulative losses. It can be argued that when cutback management is applied to social programs, losses usually exceed winnings, irrespective of strategy.

V. CONCLUSION

Four main conclusions are discussed with reference to the research findings and the work of other investigators. Aspects of the study that warrant further investigation are surveyed under *Research Implications*. Nine policy recommendations are included in *Policy Recommendations*

A. Conclusions

In their application of computers to management, systems analysts replicate specific organizational components. The process of program design and hardware configuration results in a remarkably versatile tool for understanding organizations. Otherwise hard to perceive managerial strengths and weaknesses may be exposed when writing software. Knowledge of a particular application can reveal, as in this study, the internal workings of an organization and its interactions with the political and economic environment.

The language of computer applications in many respects is the language of organizational behaviour. The extent of their correspondence is revealed in the number of key expressions common to both, among them, program, system, operations, and management information system.

Conclusions are considered under four headings: cost-benefit analysis, managerial impacts, centralizing effects,

and organizational objectives and computer systems design.

1. Cost-Benefit Analysis

The objective of assessing computer cost-benefits in terms of administration was not realized. Comparability and reliability of the limited financial information available is uncertain. Detailed records of the costs of installing and operating administrative computers throughout the B.C. public school system do not appear to be maintained by the Ministry. Some records are too rudimentary, others non-existent; for example, the Ministry does not keep an inventory of microcomputers used in school administration.

When a growing proportion of the educational budget is directed to capital and operating costs associated with data processing, failure to maintain detailed accounts seems implausible. The exercise of informed EDP choice can be achieved only when expenditures are linked to performance. Until a linkage between the two is established, the organization will remain excessively dependent on vendors for guidance on product performance – a situation strongly faulted by Wills (1979) in his study of the Canadian private sector.

None of the optimality calculations offered by Kochen and Deutsch (1980:17) on responsiveness, reliability and adequacy can be applied without solid financial information. Despite Gotlieb's qualifications (1985) regarding the reliability of cost-benefit calculations when the technology is

shifting at an unprecedented rate, detailed knowledge of past experience remains one of the best bases for policy assessment and planning.

Identification of costs provides an avenue for effecting savings, especially in the current climate of fiscal restraint. The Ministry's costly decision to ignore their own policy directive on the development of district software probably would not have occurred had rigorous accounting practices been followed. This policy directed that software developed under contract was to remain within Ministry jurisdiction. The Ministry, however, appears not to have taken possession of a major piece of financial software that was developed for the provincial school organization and subsequently installed in many districts. Had company compliance been sought, the software would have been distributed either free or for a nominal fee once the full development costs were met. Instead, each additional purchaser seems to have been billed an amount considerably in excess of the minor individual customizing that was made. Ignoring this policy directive may have resulted in the school system collectively paying for the program several times over.

A similar state of affairs exists with regard to the area licensing of proprietary software. Although no Ministry or school district policy yet exists, there are large benefits to be gained. Provincial licensing agreements with companies for microcomputer and minicomputer software would significantly reduce EDP costs. As the

situation stands, schools and districts purchase administrative computer programs individually, causing the organization to collectively pay far in excess of fair market value.

Gaining control over computer system costs is difficult (Gotlieb 1985). Until detailed accounts are kept, Ayer's and Kettinger's contention that there is little evidence that the introduction of computers has actually reduced costs in government (1983:565) will remain untested.

2. Managerial Impacts

Most educational administrators have yet to directly experience the effects of computerization in their work routines, although indirect effects have led to a more constrained management.

None of the personal administrative offices surveyed was equipped with a terminal or microcomputer. Only a few vice-principals, who occupy the lowest administrative rank, operated a computer regularly; all superordinates avoided any direct involvement. Administrative data and word processing requirements were usually performed by stenographers or secretaries. This situation departs from the case studies in the Canadian private sector cited by Menzies (1981) where virtually all senior and middle management have computer terminals which they use for analyses, report preparation, and the transmission and receipt of written communications.

The delay in installing terminals in the educational manager's office may be an artifact of the school system's historical resistance to change (Boyer 1983). Although at all levels, educational managers waxed enthusiastic on the computer's potential to improve administration, their interest waned when personal use of this equipment was considered. Rapid expansion of electronic mail service to the school districts may change their reluctance. In terms of time and accuracy, there are economic advantages to delegate a secretary to transcribe letters and reports, and for the manager to revise preliminary drafts on a word processing terminal.

Menzies' observations regarding "standarization, fragmentation, and separation of occupations and job functions" (1981:38) among clerical workers and lower administrative ranks has a parallel in British Columbia education. For all managers, the indirect effects of computerization are substantial. Executives at the apex have increased their control. The remainder have experienced a diminution in power. Their performance is more closely monitored than before. The operational vehicle for recording input is the Programing and Budgeting System, while the main output monitors are provincial examinations and student achievement tests. To these devices are added the restrictions of centralized education policy, and education and social legislation.

Bureaucracies can overextend themselves in their quest for administrative reification. The drive for central

control encounters opposing forces originating with the diverse communities which British Columbia public schools serve. Local administrators respond to local needs which may conflict with the centralized mandate. The boundaries between the control exerted by a ministry and that of the community shift continually. An administrator can take refuge from centralizing prescriptions in the transitional region between local needs and ministry mandate.

3. Centralizing Effects

When applied to the administration of public education organizations (kindergarten to grade twelve), computers have centralizing effects. Notwithstanding the absence of a cadre of computer experts stationed within the Ministry, and the independence most school districts exhibit when determining their software and hardware requirements, two factors that differentiate the distributed data processing systems of the British Columbia public school organization from others of similar size, this conclusion is supported by the following observations. Computers are used mainly to process data for the PPBS financial reform adopted by the Ministry to improve control of expenditures and planning. Subsidiary applications include the evaluation of student learning, projection of teacher supply and demand, and calculation of taxation yields. Each of these applications significantly increases the Ministry's operational control over input and throughput processes, which results in

decreased local autonomy.

Increased centralization arising from computerization supports the predictions of Laubach and Thompson (1955), and Lasswell (1971). The Ministry's documentation system possesses biases that drive policy toward centralization. Increased input, throughput and output measurement in the form of budgeting, student learning assessments and graduation examinations have produced greater centralization.

Lasswell's assertion that access to data and computer-based simulations assure democratic outcomes, although postulated in terms of national government, may also apply to public sector organizations. In the context of the British Columbia public school system, schools and school districts have limited access to the operational information of other units. The relationship postulated by Lasswell is therefore indeterminate.

None of the findings uphold de Sola Pool's expectation that acquisition of personal computers by subordinate organizational units leads to increased autonomy (1983). Conversely, many British Columbia school districts closely monitor the administrative use of school computers. Some have already instituted standardization policies for schools, while others anticipate introducing them. Most schools apply their computers to bookkeeping and student management. Although computer use may lead to improved services and cost-efficiencies, it is unlikely they will lead to greater autonomy, given the recent increase in

legislation and policies that constrain local administrative initiative.

Similar forces function at the school and school district level. The use of microcomputers and minicomputers leads to increased control of these units by administrators at these levels, but the computer-dependent control achieved by the Ministry is greater.

4. Organizational Objectives And Computer Systems Design

The multiplicity of manufacturers represented among British Columbia school district computers departs from the general rule that centralization leads to standardization. Elsewhere, leading informatic companies have encouraged standardization since their market share is enlarged and the likelihood of future sales improved. British Columbia school districts have resisted standardization for two decades. Although BCSC rapidly standardized provincial government data processing in the late 1970's, for the most part school districts thwarted Corporate and Ministry attempts to unify their data systems.

Honeywell remains the major hardware supplier and Datatech, acting as Honeywell's representative, the main software vendor. Before the introduction of the 1982 district computer project, Datatech, using Honeywell equipment, had secured the largest market share of school district online and batch services. Datatech's sales and lobbying

campaign assured its preeminence in the new project.[1]

The historical predominance of a single computer company in part confirms the observations of Fishman (1981) and Fisher et al (1983) on the emergence of a dominant informatics corporation. In the British Columbia case, control is exerted by Honeywell, not IBM. The recent success of competitors' products among sophisticated computer users leaves undecided the question whether unification of district computers will involve Honeywell specifications. Future consolidation plans must consider the prevalence of IBM Personal Computer specifications among schools and districts, and BCSC mainframe processor and networking standards. Demand for improved cost-benefits and more services will propel school district computer systems toward full compatibility with the Ministry's mainframe computing facility.

To some extent, Lasswell's insight that political issues often precede quantitative cost-efficiency concerns is upheld by these findings. In British Columbia, public service computerization became an intensely political and high-profile issue. Cabinet's reputation seemed closely tied to the success of centralized computing policies.[2]

---

[1] Honeywell was frozen out of the B.C. public service data processing market when BCSC selected IBM processors. The fate of Honeywell equipment received repeated attention in the legislature and news media. Some respondents conjectured that high-level political intervention assured a major role for Datatech in the 1982 computer project.

[2] By removing computer experts from the Ministry of Education, the centralization of government data processing facilities inhibited the emergence of strong EDP

Lobbying and an unusually high degree of political involvement was present throughout the early years of BCSC.

Gotlieb (1985:101) notes that MIS departments favour standardized hardware and software. The absence of a strong Ministry of Education MIS division coincided with system fragmentation.

B. RESEARCH IMPLICATIONS

Research will reveal how public education, an inherently conservative organization, responds to a technology which is radically changing the society in which public schooling takes place. Despite its importance, the area is largely uncharted. Analysis of the research findings gathered for this study suggest several potentially rewarding directions for research.

1. Costs and Cost-Benefits

What are the costs and cost-benefits of administrative computerization?

Establishing the costs and cost-benefits of administrative computers is critical to effective planning. Relatively little financial information seems to be generated by the Ministry for a data processing system that is itself designed to produce increased financial knowledge about provincial operations.

---

[2](cont'd) centralization forces within the school system.

Of perhaps greater concern are the economic effects computerization has on the nation. Educational organizations exist in a web of social and economic interdependencies. Assessed in terms of immediate organizational objectives, senior management's decision to respond to falling revenues by introducing a computerized Planning, Programing, and Budgeting System may be desirable. Decisions to implement these computer-dependent efficiencies and cost reductions, however, may precipitate a further cycle of decline in fiscal support from outside the immediate organization.

Unlike lumber and concrete, examples of materials manufactured in Canada, and common ingredients in school construction, computers and increasingly their software are largely imported. An historically reliable source of economic stimulation – capital expenditure on schools – decreases in effect when the goods purchased reduce employment.[3] Educational expenditure on domestic manufactures contributes to a robust residential and commercial tax base which in turn supports larger educational expenditures. When a significant portion of the educational dollar is directed outside Canada in a quest for microprocessor efficiencies, then compensatory mechanisms will have to be introduced to overcome declining educational revenues (*see* Appendix C).

---

[3] The author recognizes that computer sales are an employment source, but problems arising from Canada's historic role as an entrepôt economy are especially acute in the area of informatics.

2. Inter-provincial Cooperation

Is inter-provincial cooperation on the development of advanced computer systems warranted?

For a province in which operational uniformity between Ministry and district computers has yet to be attained, discussion of interprovincial cooperation may seem premature. The first signs of interprovincial cooperation have already appeared in a related electronic endeavour, educational television. Provincial ministries of education are as capable as the private sector of producing instructional, financial and managerial software with national relevance and marketing potential.

3. Administrative Computers and Educational Diversity

How can computer systems be designed to support educational diversity?

The British Columbia school district computerization project was designed to support a Planning, Programing, and Budgeting System. Financial cutbacks associated with PPBS and related computer initiatives at the district and Ministry level have reduced the range of educational experience. However, computer programs can be designed with the capacity to manage increased educational diversity with little if any increase in cost. The design of computerized management systems reflects the political and cultural assumptions of management. How computers are applied to the management of education may be as important as their

application to instruction.

4. Middle Management – Candidates for Computerization?

Are school and school district administrative positions good candidates for computerization?

In this study, direct managerial impact was observed only at the lowest rung. Following the pattern achieved in the commercial and public sectors, further direct incursions may be expected among middle management and executive ranks. The extent and rate at which managers in provincial public education organizations integrate computers into their work routines is of considerable interest. Will the present administrative resistance, apparently derived from managers associating computer use with clerical work, persist? Educational administrators are also likely to resist a process that under the guise of efficiency has led other organizations to vigorously apply operations research techniques to middle management. The consequences are an erosion of personal freedom and a climate where supervisors themselves are closely supervised.

C. POLICY RECOMMENDATIONS

In the years ahead, public school organizations will follow public and private sector initiatives in introducing computer systems to assist in the non-financial aspects of administration. A first step will be the provision of an online data base containing provincial policies and

legislation related to school management. Such a database will include commentaries and legal opinions of relevance to line managers.[4] A second step will be the creation of an expert system designed to guide school and school district administrators through the increasingly complex maze of federal and provincial legislation impinging on their daily routines. The expert system will also be designed for use by the Minister and senior advisors.

A number of recommendations arise from the process of comparing the British Columbia public school policy on administrative computers with the data processing practices followed in private and public jurisdictions. The following synopsis of the most prominent recommendations relates specifically to British Columbia, but may also apply to other jurisdictions. These recommendations can serve as departure points for further research.

1. Ministry Coordination of EDP Purchases

Coordinate purchases at the Ministry level of computers and software for the entire organization.

Price leverage is reduced when seventy-five school districts and many more schools individually purchase their EDP equipment. Data processing equipment for schools and school districts should be purchased through the British Columbia

[4] The British Columbia School Trustees Association has already placed their legal opinions concerning current district mananagement questions in an electronic file which is accessed by school district subscribers through a privately operated electronic mail system.

Purchasing Commission after consultation with BCSC and the Ministry.

2. Standardize Informatics Components

Standardize operating systems, applications and computers. Develop modular programs for school and school district administration.

Standardization maximizes potential cost-benefits. Communication via a provincial public school network is facilitated when there are common terminals and processors. Standardization will justify the high cost of preparing an expert system and other data bases by distributing the financial burden.

3. Common Operating System

Make school microcomputers, district minicomputers and mainframes, and the Ministry mainframe run on a common operating system.

The objective, as in item two, is to improve communications, reduce costs and increase flexibility.

4. Use BCSC Communications Network

Use the provincial communications network operated by the British Columbia Systems Corporation.

BCSC has an advanced, high-speed electronic network with nodes in most major provincial centres. Although users pay for long-distance telephone connections to the nodes,

downline access is without charge. More sophisticated messaging appears to be possible with the BCSC network than with the commercial Envoy electronic mail service. The number of school and school district subscribers to Envoy continues to grow – resulting in considerable equipment redundancy for the education system.

5. Transmit Data Electronically

Move statistical and financial records electronically through the medium of magnetic tape, floppy disk, and high speed data
transmission.

In the fallout of financial reform, the types and quantity of manually prepare forms seem to have climbed. Much time is consumed by district staff manually transfering data processing results to prescribed Ministry forms, followed by hand sorting and data re-entry via Ministry terminals. These procedures are wasteful; better to fully-modernize information handling by introducing electronic data transmission for all vital financial and statistical information.[5]

[5] An indication that the Ministry is moving in this direction is exemplified by by the field trial to be conducted by BCRC and the Vancouver School District in June, 1986 which will involve the exchange of magnetic tapes. The tapes will contain student data relating to senior secondary graduation.

6. Establish a Division of Informatics

The Ministry will establish a division responsible for systems analysis, programs, and coordination of the entire provincial administrative informatics system.

A common element unites Canadian public school organizations that possess advanced EDP systems: strong central departments manage administrative informatics. Circumspect Ministry direction in this rapidly changing field is not possible without employing a group of full-time experts. Short-term employment contracts and poorly informed committees have led to many EDP problems.

An MIS branch will comprise capable programers and systems analysts. The branch will oversee on-site testing of hardware and software at the school and school district level. Its mandate will include the realization of the recommendations cited here.

7. Retain Ownership of Software Developed Under Contract

Ownership and distribution rights to be retained by the Ministry for program development contracted to private companies. Provincial licences will be sought for proprietary software.

Again, cost reduction is a prime objective. The status of software ownership developed under contract is addressed in the Ministry's 1982 computer policy. Subsequent action appears to have departed from this directive. Were the Ministry to retain ownership, software could be exchanged

with other provinces.

Steps should be taken to license popular off-the-shelf software for school and district administration on a provincial basis. Licensing agreements for educational software have already been concluded by the Ministry's Provincial Educational Media Centre. Licences are popular with private companies; they allow the recipient to make a designated number of copies for distribution throughout the organization.

8. Institute Full Informatics Accounting Practices

Institute accounting practices that support cost-benefit and cost-efficiency analyses of informatics.

Policy-making is severely handicapped by insufficient financial information on the relative cost of equipping and operating various computer options. This information will be linked with performance data obtained from detailed field trials as suggested in recommendation six (page 189). This information could also serve the federal government when national policies are evolved to address the relationship between public service informatics and the weakening Canadian economy. The financial implications for education of a shrinking domestic tax base coupled with a substantial extra-national capital outflow arising from hardware and software purchases is discussed in Appendix C.

9. Seek Cooperation Between Provincial Ministries of Education

Cooperate with other education ministries to develop hardware, and modular computer programs.

Privately packaged programs, such as those for bookkeeping and inventory, are popular in the British Columbia school system. No significant obstacles block provincial ministries from jointly producing administrative software packages. Many mainframe-, minicomputer-, and microcomputer-based student management, financial, and accounting programs sold to British Columbia school districts are slightly modified versions of products distributed across Canada and the United States. Modular software jointly produced at a national centre could be customized by individual provincial ministries.

The high cost of writing complex programs, particularly expert systems, provides a strong incentive for cooperative development. Operating and application system incompatibility between provinces hinders the extent of current interprovincial cooperation, but with complete hardware replacement occurring every five years, the realization of interprovincial computer standards for educational administration is a reasonable expectation.

D. AFTERWORD

Any consideration of the application of computers to the administration of a public school system should consider their effect on the education of young people. In British Columbia, several million dollars are spent each year on the acquisition and operation of administrative computers within the school system. Does this expenditure improve educational outcomes in the classroom?

If the annual cost, including salary and benefit package, of employing a recently graduated secondary school teacher is approximately thirty-three thousand dollars,[6] then thirty-three teachers could be hired for each one million dollars currently spent on administrative computers. Some may argue that were a decision made to direct these funds from administration toward the classroom, only a relatively small number of students would benefit. Although the overall change may be small, for those students directly affected the impact would be significant.

There is little evidence to indicate that administrative computers have improved the educational experience of young people. On the contrary, the recent expansion of computer use in British Columbia is closely associated with educational cutbacks, narrower course and curriculum offerings, larger class sizes, and reductions in the number of classroom teachers. These events have brought educational impoverishment.

---

[6] based on Statistics Canada and British Columbia Teachers' Federation respondents; Statistics Canada 1985b; BCTF 1984b)

Certainly some aspects of student learning are more closely tracked, and educational expenditures are monitored in greater detail, but measurement alone does not lead to educational improvement. Placing more teachers in schools, ensuring that students are properly clothed and nourished, and that they have good educational facilities, are central components of any plan to improve learning. The formula is simple and effective.

Good education costs; better education costs more. When the state educates large numbers of college and university graduates to deny them, on graduation, productive roles in the education of school students, one must ask: To what end do we measure? To what ends do we educate?

The application of computers to public school administration is part of a larger social revolution in which computers and associated industrial processes continue to disemploy ever more people. Salaried and wage related jobs have, in the past, provided a means to redistribute social resources. As these labour employment mechanisms are made redundant, other means of resource distribution must be implemented to foster social vitality. Learning and the education of others present opportunities for all to share in our cultural and material heritage. These endeavours provide some of the most important means of distributing wealth and assuring social vigour.

The recent British Columbia scenario, in which the very machines that have the potential to enrich learning are used

instead to reduce educational opportunity, must surely rank as one of the less productive applications possible. The rising importance of computers throughout the global community should herald substantial increases in public school expenditure; increases that will be directed toward improving classroom conditions and reducing class size.

GLOSSARY[1]

batch Originally, a method of organizing work for a computer system, designed to reduce overheads by grouping together similar jobs. The jobs were collected into batches, each batch requiring a particular compiler, the compiler loaded once, and then the jobs submitted in sequence to the compiler. At the end of the batch of compilations those jobs that had produced an executable binary form were loaded in sequence and their data presented to the jobs. The term has also come to be applied to the background processing of jobs not requiring intervention by the user, which takes place on many multiaccess systems.

central processing unit The arithmetic and logic unit (ALU) and the control unit (CU) and sometimes, but not always, the primary memory. As the functions in a computing system have become more autonomous, the specification of the CPU has become less significant.

cost-benefit analysis A determination of the relationship between cost and benefit in choosing between alternative courses of action. A management scientist, a political scientist or a sociologist may adopt a different view or consider quite different factors in the accounting. The usual case is that costs are identified readily, but that benefits are more intractable because there are important ones which are intangible or unquantifiable. In situations where service centres are not operated as profit or cost centres, as happens in the public sector, even determining costs can present problems, because of accounting and budgeting rules which do not allow amortization of capital equipment or carryover of funds from one fiscal period to the next.[2]

data entry The process in which an operator uses a keyboard or other device to input data directly into a system.

database A collection of interrelated data values of such a nature that they might be represented as a number

---

[1] The Glossary draws extensively on the *Dictionary Of Computing* by Valerie Illingworth, Edward L. Glaser and I. C. Pyle, 1983.

[2] Extract from *The Economics Of Computers* by Calvin Gotlieb, 1985, page 124.

of files but not a single file. Depending upon the nature of the database management system, these files may be integrated permanently into a single connected structure or integrated temporarily for each interrogation.

distributed data processing The organization of processing to be carried out on a distributed system. Each process is free to process local data and make local decisions. The processes exchange information with each other over a data communication network to process data or to read decisions that affect multiple processes.

electronic data processing Refers either to a class of computer applications or to a function within the organization. Data processing applications may be characterized as those that store and process large quantities of data on a routine basis, in order to be able to produce information that is required.

electronic mail Messages sent from one user of a computer system to one or more recipients (or the conveyance of such messages), the computer system being used to hold and transport messages. Sender and receivers need not be online at the same time, or even on the same computer to communicate. Electronic mail is an important component of an office automation system.

floppy disk A magnetic information storage medium consisting of a circular polyester substrate coated on one or both sides with magnetic oxide and enclosed within a stiff envelope, the inside of which is coated with a cleaning material. The envelope has a radial slot – or two slots for a double-sided floppy disk – through which the read/write heads of a floppy-disk drive can contact the disk. A hole in the envelope and disk is provided so that a photosensor may be used to generate an index pulse once per revolution signal.

hard disk A magnetic recording medium consisting of an aluminum substrate coated or plated – usually on both sides – with a magnetic material.

informatics The study of information and its handling, especially by means of new information technology, including computers and telecommunications. The expression also designates a system, as in 'informatics system.' A. I. Mikhailove, a Russian communications theorist, originated the term (Garfield 1986).

local area network A high-speed communication network

linking a number of stations in the same 'local' area, variously defined as the same building, a radius of one kilometer, or a single plant.

mainframe Generally, the combination of central processor and primary memory of a computer system. Any large computer system. The distinction between mainframe and minicomputer is becoming blurred.

management information system An information system whose prime purpose is to supply information to management.

memory A device or medium that can retain information for subsequent retrieval. The term is synonymous with storage and store, although it is most frequently used for referring to the internal storage of a computer that can be directly addressed by operating instructions.

microcomputer A computer system that utilizes a microprocessor as its central control and arithmetic element. As microprocessors become still more powerful and peripheral devices become more cost-effective, microcomputers will continue to encroach on the domain of minicomputers and the distinction between them will blur, if not disappear.

microprocessor A semiconductor chip, or chip set, that implements the central processor of a computer. Microprocessors consist of, at minimum, an arithmetic and logic unit and a control unit.

network In communications, a rather loosely defined term applied to a system that consists of terminals, nodes and interconnection media that can include lines or trunks, satellites, microwave, medium- and long-wave radio, etc. In general, a network is a collection of resources used to establish and switch communication paths between its terminals.

online Connected to the system and usable.

operating system The set of software products that jointly controls the system resources and the processes using these resources on a computer system.

planning, programing, and budgeting system A totally integrated computer dependent process that extends from the planning and analysis functions through programing and budgeting into operations, reporting and control.

processor A computer, usually/often the central processor.

systems analysis Is the analysis of the role of a proposed system and the identification of a set of requirements that the system should meet. It forms the starting point for system design.

systems network architecture The logical structure, formats, protocols, and operational sequences for transmitting information units through, and controlling the configuration and operation of networks. This interface is the foundation of IBM's unified informatics strategy.

text processing Another name for word processing.

word processing An office automation facility that enables users to compose documents using a computer with facilities to edit, re-format, store, and print documents with maximum flexibility. A typical word processing facility consists of a video terminal, word processing program, store and printer.

BIBLIOGRAPHY

Abelson, Philip H. & Allen L. Hammond. (1981). The Electronics Revolution. ***The Microelectronics Revolution.*** (ed) Tom Forester, Cambridge: Massachusetts Institute Of Technology, 16-28.

Abrahamson, Mark. (1983). ***Social Research Methods.*** Toronto: Prentice-Hall.

Akers, John F. (1984). A Responsible Future — An Address To The Computer Science Industry. ***Sloan Management Review.*** Cambridge: Massachusetts Institute Of Technology, Vol. 26, No. 1, Fall, 53-57.

Alberta. (1983). ***Computers In Schools: Report Of The Minister's Task Force On Computers In Schools (Executive Summary).*** Edmonton: Alberta Education, 1-19.

Allen, Brandt. (1982). An Unmanaged Computer System Can Stop You Dead. ***Harvard Business Review.*** Boston: Harvard, Vol. 60, No. 6, Nov.-Dec., 77-87.

Anderson, G. Ernest, Jr. (1967). Educational Data Processing In Local School Districts. ***The Computer In American Education.*** (eds) Don D. Bushnell & Dwight W. Allen, New York: John Wiley, 204-215.

Andrews, John H. M. (1985). ***Parent Reaction To Financial Restraint In The Vancouver Schools.*** Vancouver: Vancouver School Board, 1-44.

Archbold, Pamela & John Verity. (1985). A Global Industry... The 'Datamation 100.' ***Datamation.*** New York: Technical Publishing, Vol. 31, No. 11, June 1, 36-182.

Archer, James E., Richard Conway & Fred B. Schneider. (1984). User Recovery And Reversal In Interactive Systems. ***ACM Transactions On Programming Languages And Systems.*** New York: Association For Computing Machines Inc., Vol. 6, No. 1, January, 1-19.

Arendt, Hannah. (1979). ***Eichmann In Jerusalem: A Report On The Banality Of Evil.*** Markham: Penguin.

Ayers, Whitfield Q. & William J. Kettinger. (1983). Information Technology And Models Of Governmental Productivity. ***Public Administration Review.*** Washington: American Society For Public Administration, Vol. 43, No. 6, Nov.-Dec., 561-566.

Bacon, Francis. (1825). Of Heresies. *in* Meditationes Sacrae. ***The Works Of Francis Bacon.*** (ed) Basil Montague, London: William Pickering, Vol. 1, 217-220.

Ball, Taylor (ed). (1984). 31 Quebec School Boards Use Burroughs Systems In Huge Network. ***Solutions.*** Detroit: Burroughs Corporation, Vol. 6, No. 1, February, 38-40.

Barna, Rebecca S. (1985). Editorial. ***Datamation.*** New York: Technical Publishing Co., Vol. 31, No. 1, January 1, 19.

Barrett, Derm & Keith Oman. (1983). Micro-Based Performance And Productivity For Managers And Professionals. ***Business Quarterly: Canada's Management Journal.*** London: University Of Western Ontario, Vol. 48, No. 1, Spring, 61-69.

Baumol, William J. & Maco Stewart. (1971). On The Behavioural Theory Of The Firm. ***The Corporate Economy: Growth, Competition And Innovative Potential.*** (eds) Robin Marris & Adrian Wood, Cambridge: Harvard University Press, 118-143.

Bavelas, Alex, James MacGregor & Frank Safayeni. (1984). ***The Office As An Information Processing System: A Conceptual Model And Methodology For Field Study.*** Ottawa: Department Of Communications, Vol. 3, Behavioural Research In Office Communications, 1-68.

BCSC. *see British Columbia Systems Corporation.*

BCSTA. *see British Columbia School Trustees Association.*

BCTF. *see British Columbia Teachers' Federation.*

Beck, Michael P. & Benjamin W. Lin. (1981). Selection Of Automated Office Systems: A Case Study. ***Omega: The International Journal Of Management Science.*** Exeter: Pergamon Press, Vol. 9, No. 2, 169-176.

Behiels, Michael D. (1985). ***Prelude To Quebec's Quiet Revolution: Liberalism Versus Neo-nationalism 1945-1960.*** Montreal: McGill-Queen's University Press

Bell, Daniel (1973). ***The Coming Of Post-Industrial Society: A Venture In Social Forecasting.*** New York: Basic Books.

———. (1979). Thinking Ahead: An Information Revolution Presents New Opportunities And New Problems For Business And Society. ***Harvard Business Review.*** Boston: Harvard, Vol. 57, No. 3, May-June, 20-41.

Bell, Kenneth. (1983). Pre-bid Axe Chops BCSC Managers. ***The Province.*** Vancouver: Southam, Dec. 7., 17.

Benedict, Ruth. (1974). ***The Chrysanthemum And The Sword: Patterns Of Japanese Culture.*** New York: New American Library.

Berra, Bruce P. (1983). The Role Of Data Base Machines In A Distributed Data Base Environment. ***IEEE 1983 Eascon.*** (15th Annual Electronics and Aerospace Conference). New York: Institute Of Electrical And Electronic Engineers, 361-365.

Bingham, John E. & Garth W. P. Davies. (1978). ***A Handbook Of Systems Analysis.*** 2nd ed. London: MacMillan.

Binns, Douglas Gordon. (1983). Administrative Computing In British Columbia Junior Secondary Schools: A Survey Of Trends And Implications. unpublished manuscript, University Of British Columbia, 1-110.

Binns, Douglas Gordon & Daniel J. Brown. (1985). A Study Of Administrative Computing In British Columbia Junior Secondary Schools. ***Cue.*** Vancouver: British Columbia Teachers' Federation, Computer Using Educators Of British Columbia, Vol. 4, No. 3, Spring, 5-22.

Bird, Patrick J. (1983). ***The Use Of Low Cost Micro-Processor Based Computer Systems In School Administration And Management.*** A Report To The Department Of Education And Science. Bristol: University Of Bristol, School Of Education, 1-151.

———. (1984). ***Microcomputers In Educational Administration.*** London: Hutchinson.

Bloch, Marc. (1961). ***Feudal Society: The Growth Of The Ties Of Dependence.*** Vol. I, translated L. A. Manyon, Chicago: University of Chicago.

Bogdan, Robert C. & Sari Knopp Biklen. (1982). ***Qualitative Research For Education: An Introduction To Theory And Methods.*** Toronto: Allyn & Bacon.

Booth, Peter J. & Teresa I. Plowright. (1982). ***A Study On The Social Impacts Of Office Automation.*** Ottawa: Department Of Communications, Vol. 2, Behavioural Research In Office Communications, 1-213.

Borg, Walter R. & Meredith Damien Gall. (1979). ***Educational Research: An Introduction.*** 3rd ed. New York: Longman.

Borrus, Michael & John Zysman. (1985). Alliances, Networks, And International Competition. ***Datamation.*** New York: Technical Publishing, Vol. 1, No. 11, June 1, 187-193.

Bosanquet, Nick. (1983). ***After The New Right.*** London: Heinemann.

Boyer, Ernest L. (1983). ***High School: A Report On Secondary Education In America.*** The Carnegie Foundation For The Advancement Of Teaching. New York: Harper & Row.

Boyle, Eleanor. (1978). B.C.'s Computer Jugernaut Moves Into Gear. ***Vancouver Sun.*** Vancouver: Pacific Press, March 29, D8.

Brackett, John & Jay Chambers et al. (1983). The Legacy Of Rational Budgeting In Education. unpublished manuscript, Stanford: Institute For Research On Educational Finance And Governance, 1-70.

Braemer, Max. (1984). Intelligent Knowledge Based Systems. ***New Information Technology.*** (ed) Alan Burns, Toronto: John Wiley, 148-159.

Branscomb, Lewis M. & Paul C. Gilmore. (1975). Education In Private Industry. ***Daedalus.*** Journal Of The American Academy Of Arts And Sciences, Cambridge: Harvard University, Vol. 104, No. 1, Winter, 222-233.

British Columbia. (1977). Ministerial Titles Amendment Act, 1977. ***British Columbia Statutes.*** Victoria: Queen's Printer, Proclaimed October 21, 1977, 551-572.

———. (1978). System Act. ***British Columbia Statutes.*** Victoria: Queen's Printer, Proclaimed September 1, 1977, 251-262.

———. (1981). Budget And Administrative Policy: British Columbia Systems Corporation. Victoria: Treasury Board Staff, Chapter 25, December 1, 1-3.

———. (1982a). Financial Administration Act, 1982. ***British Columbia Statutes.*** Victoria: Queen's Printer, Proclaimed July 24, 1981, 87-121.

———. (1982b). Education (Interim) Finance Act. ***British Columbia Statutes.*** Victoria: Queen's Printer, Effective December 31, 1981; Repealed December 31, 1984, 5-21.

———. (1983a). ***Restraint And Recovery: The Next Steps.*** Government Information Services, Victoria: Queen's Printer, 1-26.

———. (1983b). Public Sector Restraint Act. ***British Columbia Statutes.*** Victoria: Queen's Printer, Effective October 26, 1983, 139-146.

———. (1983c). Education (Interim) Finance Amendment Act, 1983. ***British Columbia Statutes.*** Victoria: Queen's Printer, Effective October 26, 1983, 75.

———. (1983d). Property Tax Reform Act (No. 2), 1983. ***British Columbia Statutes.*** Victoria: Queen's Printer, Effective January 1, 1984, 121-127.

British Columbia. ***Debates Of The Legislative Assembly (Hansard).***

———. (1977). August 15, Afternoon Sitting, 2nd Session, 31st Parliament. Victoria: Queen's Printer, Vol. 6, No. 20, 4559-4596.

———. (1979a). June 22, Morning Sitting, 1st Session, 32nd Parliament. Victoria: Queen's Printer, Vol. 1, No. 16, 321-340.

———. (1979b). June 25, Afternoon Sitting, 1st Session, 32nd Parliament. Victoria: Queen's Printer, Vol. 1, No. 17, 341-370.

———. (1981a). March 18, Afternoon Sitting, 3rd Session, 32nd Parliament. Victoria: Queen's Printer, Vol. 8, No. 20, 4609-4632.

———. (1981b). March 24, Afternoon Sitting, 3rd Session, 32nd Parliament. Victoria: Queen's Printer, Vol. 8, No. 26, 4735-4758.

———. (1981c). June 9, Afternoon Sitting, 3rd Session, 32nd Parliament. Victoria: Queen's Printer, Vol. 11, No. 14, 6071-6095.

———. (1982). May 13, Morning Sitting, 4th Session, 32nd Parliament. Victoria: Queen's Printer, Vol. 14, No. 20, 7553-7564.

British Columbia Ministry Of Education. (1944—1985). ***Ministry Of Education Annual Reports.*** 1944-45 to 1984-85 inclusive, Victoria: Queen's Printer.

———. (1977a). ***A Program For A Financial And Administrative Information System.*** Victoria: Ministry Of Education, March, 1-25.

———. (1977b). ***The B.C. Reading Assessment: Summary Report.*** Victoria: Ministry Of Education, October, 1-58.

———. (1978). Financial And Administrative Information System Program. Scope Document. Victoria: Ministry Of Education, January 17, 1-20.

———. (1979). ***Lower Mainland School District Computer Needs: Summary Report.*** Victoria: Information Services, Ministry Of Education, August, 1-26.

———. (1981). School District Computer Acquisition Policy. Victoria: Ministry Of Education, 1-14.

———. (1982a). ***B.C. School District Administrative Computer Systems.*** Victoria: Ministry Of Education, 1-298.

———. (1982b). ***B.C. School District Administrative Hardware/Software Catalogue.*** Victoria: Ministry Of Education.

———. (1983a). Computer Acquisition Program For School Districts (Revised). Victoria: Ministry Of Education, January, 1-16.

———. (1983b). Administrative Computers. Ministry Information Circular. Victoria: Ministry Of Education, March 14, 1.

———. (1983c). ***Program Accounting And Budgeting Manual.*** Victoria: Ministry Of Education, October, 1-235.

———. (1984). ***1982/83 Annual Report Statistical Tables.*** Victoria: Queen's Printer, April 1, 1-162.

British Columbia Ministry Of Finance. (1970-1984). ***Public Accounts Of British Columbia, Volume I - Financial Statements.*** 1970/71 to 1983/84 inclusive, Victoria: Queen's Printer.

British Columbia School Trustees Association. (1969). ***Regional Education Data Processing Centres.*** Brief To Minister Of Education, Vancouver: BCSTA, July 11, 1-6.

———. (1984a). Electronic Mail Network Ready To Go. ***BCSTA Report.*** Vancouver: BCSTA, Vol. 79, No. 18, January 10, 1.

———. (1984b). Envoy Users Take Note. ***BCSTA Report.*** Vancouver: BCSTA, Vol. 79, No. 37, June 27, 5.

———. (1984c). The North Coast Branch Network. unpublished manuscript, Vancouver: BCSTA, 1-8.

———. (1984d). ***BCSTA Report.*** Vancouver: BCSTA, Vol. 80, No. 2, September 9, 1-6.

———. (1985). Envoy Users Kept Busy. ***BCSTA Report.*** Vancouver: BCSTA, Vol. 80, No. 15, March 20, 2.

British Columbia Systems Corporation. (1978—1984). ***Annual Reports, 1978-79 to 1984-85.*** Victoria: B.C. Systems Corporation.

British Columbia Teachers' Federation. (1983). ***1983 Education Finance In British Columbia.*** Vancouver: Bargaining Division, 1-40.

———. (1984a). ***1984 Education Finance In British Columbia.*** Vancouver: Bargaining Division, 1-45.

———. (1984b). ***Statistics Handbook 1984-85.*** Vancouver: Bargaining Division, 1-465.

———. (1984c). ***1984: The Computer Age Takes Over School Board Budgets.*** Vancouver: BCTF, May 28, 1-5.

Bronsema, Gloria S. & Peter G. W. Keen. (1983). Education, Intervention And Implementation In MIS. ***Sloan Management Review.*** Cambridge: Massachusetts Institute Of Technology, Vol. 24, No. 4, Summer, 35-43.

Brooke, Michael Z. (1984). ***Centralization And Autonomy: A Study In Organization Behaviour.*** Toronto: Holt, Rinehart & Winston.

Brooks, Frederick P., Jr. (1982). ***The Mythical Man-Month: Essays On Software Engineering.*** Revised, Reading: Addison-Wesley.

Brown, Daniel J. (1977). Towards The Optimization Of Educational Inventory Systems. ***AEDS Journal.*** Washington: Association For Educational Data Systems, Vol. 11, No. 1, Fall, 14-24.

———. (1983). Decentralization Of Decision Making In Educational Finance: The Consideration Of School-Based Management. unpublished manuscript, Vancouver: University of British Columbia.

———. (1985). Computers And Administration: Inquiry Needed On The Future Organization Of Schools. paper prepared for Canadian Society For The Study Of Education, May Conference, 1-5.

Brown, Daniel J., Brian Kirkbride & Manfred Reusse. (1982). The Microcomputer For School Administrators: A Study Of Cost-Effectiveness And Change. unpublished manuscript, Vancouver: University Of British Columbia, 1-38.

Brown, Daniel J. & Manfred Reusse. (1983). User Perceptions On The Cost Effectiveness Of Microcomputers For School Administration. ***The Canadian School Executive.*** Edmonton: University Of Alberta, Vol. 3, No. 3, May, 12-16.

Budiansky, Stephen. (1985). Supercomputers: Intel's Hypercube Architecture. ***Nature: International Weekly Journal Of Science.*** London: MacMillan Journals, Vol. 313, No. 6004, February 21, 616.

Budiansky, Stephen. (1985). Infant Mortality: U.S. Improvement Halted. ***Nature: International Weekly Journal Of Science.*** London: MacMillan Journals, Vol. 314, No. 6009, March, 305.

Burch, John G., Jr. & Felix R. Strater, Jr. (1974). ***Information Systems: Theory And Practice.*** Santa Barbara: Hamilton.

Burns, Alan. (1984). ***New Information Technology.*** Toronto: John Wiley.

Burns, Tom. (1974). On The Rationale Of The Corporate System. ***The Corporate Society.*** (ed) Robin Marris, London: Macmillan, 121-177.

Buss, Martin D. J. (1982). Managing International Information Systems. ***Harvard Business Review.*** Boston: Harvard, Vol. 60, No. 5, Sept.-Oct., 153-162.

———. (1983). How To Rank Computer Projects. ***Harvard Business Review.*** Boston: Harvard, Vol. 61, No. 1, Jan.-Feb., 118-125.

Bylinsky, Gene. (1981). Here Comes The Second Computer Revolution. ***The Microelectronic Revolution.*** (ed) Tom Forester, Cambridge: Massachusetts Institute Of Technology, 3-15.

———. (1984). The Holes In AT & T's Computer Strategy. ***Fortune.*** Los Angeles: Time, Vol. 110, No. 6, Sept. 17, 68-82.

Caiden, Naomi. (1985). The Boundaries Of Public Budgeting: Issues For Education In Tumultuous Times. ***Public Administration Review.*** Washington: American Society For Public Administration, Vol. 45, No. 4, 495-502.

Campbell, Donald T. (1955). The Informant In Quantitative Research. ***The American Journal Of Sociology.*** Chicago: University Of Chicago Press, Vol. LX, No. 4, January, 339-342.

Campbell, Donald T. & Donald W. Fiske. (1959). Convergent And Discriminative Validation By The Multitrait-Multimethod Matrix. ***Psychological Bulletin.*** Washington: American Psychological Association, Vol. 56, No. 2, March 81-105.

Campo, George, Carol Pickup & Mike Suddaby. (1984). ***Agassiz-Harrison Commission Of Inquiry.*** Vancouver: British Columbia Teachers' Federation, February, 1-31.

Canada. (1977). ***Royal Commission On Financial Management And Accountability. Progress Report.*** Ottawa: Supply And Services, 1-49.

———. (1979). ***Royal Commission On Financial Management And Accountability. Final Report.*** Ottawa: Supply And Services, 1-586.

———. (1983). ***Canada Tomorrow Conference: Proceedings.*** Ottawa: Science And Technology Canada, November.

———. (1984). ***Information Technology Vocabulary.*** Ottawa: Supply And Services, 1-200.

———. (1985). ***Annual Report Privacy Commissioner 1984-85.*** Ottawa: Supply And Services, 1-29.

Canadian Broadcasting Corporation. (1984). ***Telematics.*** CBC Ideas Transcript, Toronto: Canadian Broadcasting Corporation, 1-47.

Canadian Information Processing Society. (1985). 1985 Census Summary Tables. ***CIPS Review/La Review CIPS.*** Toronto: Canadian Information Processing Society, Vol. 9, No. 2, March-April, 8-9.

Carlin, Edgar M. & Daniel Brown. (1985). ***Careers And Issues: A Survey Of The Superintendency.*** Vancouver: Department Of Administrative, Adult And Higher Education, University Of British Columbia.

Carr, Edward Hallett. (1965). The Historian And His Facts. ***What Is History?*** New York: Alfred Knopf, 3-35.

Chang, Shi-kuo (ed). (1984). ***Management And Office Information Systems.*** New York: Plenum Press.

Churchman, C. W. & A. H. Schainblatt. (1969). PPB: How Can It Be Implemented? ***Public Administration Review.*** Washington: American Society For Public Administration, Vol. 29, No. 2, March-April, 178-189.

CIPS. *see Canadian Information Processing Society.*

Cleveland, Harlan. (1985). The Twilight Of Hierarchy: Speculations On The Global Information Society. ***Public Administration Review.*** Washington: American Society For Public Administration, Vol. 45, No. 1, Jan.-Feb., 185-195.

Clippinger, Richard F. (1955). Economics Of The Digital Computer. ***Harvard Business Review.*** Cambridge: Harvard University, Vol. 33, No. 1, Jan.-Feb., 77-88.

Cohen, David K. (1984). The Condition Of Teachers' Work. ***Harvard Educational Review.*** Cambridge: Harvard University, Vol. 54, No. 1, 11-15.

Columbia Computing Services Ltd. (1984a). ***The School System: Attendance.*** Vancouver: Columbia Computing, 1-540.

———. (1984b). ***The School System: Marks Reporting User's Manual.*** Vancouver: Columbia Computing, 1-168.

———. (1984c). ***The School System: Student Scheduling.*** Vancouver: Columbia Computing, 1-356.

Communications Canada. *see Department Of Communications.*

Conference Reports. (1983). Information Systems Design Methodologies: A Comparative Review. ***Information And Management: The International Journal Of Information Systems Applications.*** Amsterdam: North Holland, Vol. 6, No. 1, February, 51-55.

Conrad, Michael. (1985). On Design Principles For A Molecular Computer. ***Communications Of The ACM.*** New York: Association For Computing Machinery, Vol. 28, No. 5, May, 464-480.

Coquitlam School District. (1977). Minutes Of School Board Meeting For April 26, 1977. unpublished, Port Coquitlam: School District #43, 8.

Côté, Marcel, Yvan Allaire & Roger-Emile Miller. (1976). ***IBM Canada Ltd: A Case Study.*** Royal Commission On Corporate Concentration, Ottawa: Supply And Services.

Crecine, John P. (1986). The Next Generation Of Personal Computers. ***Science.*** Washington: American Association For The Advancement Of Science, Vol. 231, No. 4741, 935-943.

Cron, William L. & Marion G. Sobol. (1983). The Relationship Between Computerization And Performance: A Strategy For Maximizing The Economic Benefits Of Computerization. ***Information And Management.*** Amsterdam: North Holland, Vol. 6, No. 3, June, 171-181.

Crozier, Michel & Erhard Friedberg. (1980). ***Actors And Systems: The Politics of Collective Action.*** translated by Arthur Goldhammer, Chicago: University Of Chicago.

Culbertson, Jack A. (1981a). Three Epistemologies And The Study Of Education. ***Review.*** Columbus: University Council For Educational Administration. Vol. 22, No. 1, Winter, 1-12.

———. (1981b). ***Moving Education And Its Administrators Into The Microelectronics Age.*** UCEA Career Development Seminar, Austin: University Of Texas, May 19-21.

Curley, Kathleen Foley & Philip J. Pyburn. (1982). "Intellectual" Technologies: The Key To Improving White-Collar Productivity. ***Sloan Mangement Review.*** Cambridge: Massachusetts Institute Of Technology, Vol. 24, No. 1, Fall, 31-39.

Cutt, James & Richard Ritter. (1984). ***Public Non-Profit Budgeting: The Evolution And Application Of Zero-Based Budgeting.*** Toronto: Institute Of Public Administration Of Canada, No. 9.

Dale, Roger, Geoff Esland, Ross Fergusson et al (eds). (1981). ***Education And The State: Schooling And The National Interest, Volume II.*** Basingstoke: Open University.

Dallaire, Gene. (1984). Should Congress Provide Special Tax Incentives For Firms Donating Computers To Schools? ***Communications Of The ACM.*** New York: Association For Computing Machinery, Vol. 27, No. 3, March, 185-194.

Danylchuk, Jack. (1979). The Up, Down Antics Of 'Chaos Corp.' ***B.C. Business Week.*** Vancouver: Pacific Rim Publishing, May 9, 12.

———. (1980). The Dangers Of Opening Up The Public Files. ***Victoria's Monday Magazine.*** Victoria: Monday Publishing Ltd., Vol. 6, No. 42, Oct. 17, 12.

———. (1981a). A Digital Disaster: Musical Computers At BCSC. ***Victoria's Monday Magazine.*** Victoria: Monday Publishing Ltd., Vol. 7, No. 14, April 3, 8.

———. (1981b). Shortcircuiting Efficiency At BCSC. ***Victoria's Monday Magazine.*** Victoria: Monday Publishing Ltd., Vol. 7, No. 15, April 10, 8.

———. (1983a). Rumours Of BCSC's Demise Off The Mark. ***The Vancouver Sun.*** Vancouver: Pacific Press, Aug. 2, B7.

———. (1983b). Plan To Sell Computer Firm Hit By Software Developers. ***The Vancouver Sun.*** Vancouver: Pacific Press, Sept. 6, A3.

———. (1983c). Data Employees Bid For Control. ***The Vancouver Sun.*** Vancouver: Pacific Press, Dec. 12, B8.

———. (1984a). B.C. Firms Relieved. ***Financial Post.*** Toronto: Maclean Hunter, April 28, 7.

———. (1984b). Will Anyone Take BCSC? ***Victoria's Monday Magazine.*** Victoria: Monday Publishing Ltd., Vol. 10, No. 20, May 10-16, 14-15.

Danzinger, James N., William H. Dutton, Rob Kling et al. (1982). ***Computers And Politics: High Technology In American Local Governments.*** New York: Columbia University.

Darkenwald, Gordon G. (1980). Field Research And Grounded Theory. ***Changing Approaches To Studying Adult Education.*** (eds) Huey B. Long, Roger Hiemstra et al, San Francisco: Jossey-Bass.

Date, C. J. (1976). ***An Introduction To Database Systems.*** IBM (U.K.) Laboratories Ltd., Don Mills: Addison-Wesley.

Deardon, John. (1966). Myth Of Real-Time Management Information. ***Harvard Business Review.*** Boston: Harvard, Vol. 44, No. 3, 123-132.

———. (1972). MIS Is A Mirage. ***Harvard Business Review.*** Boston: Harvard. Vol. 50, No. 1, Jan.-Feb., 90-99.

———. (1973). How To Control The Computer Resource. ***Harvard Business Review.*** Boston: Harvard, Vol. 51, No. 6, Nov.-Dec., 68-78.

———. (1983). Will The Computer Change The Job Of Top Management? ***Sloan Management Review.*** Cambridge: Massachusetts Institute Of Technology, Vol. 24, No. 4, Fall, Vol. 24, No. 4, Fall, 57-60.

Demb, Ada. (1979). ***Computer Systems For Human Systems.*** Oxford: Pergamon.

DeMelto, Dennis P., Kathryn E. McMillan & Russel M. Wills. (1980). Preliminary Report: Innovation And Technological Change In Five Canadian Industries. Ottawa: Economic Council Of Canada, Discussion Paper No. 176.

Denning, Peter J. (1985). The Science Of Computing. **American Scientist.** New Haven: Sigma Xi, The Scientific Research Society, Vol. 73, No. 5, Sept.-Oct., 414-416.

Denning, Peter. (ed), Edward Feigenbaum, Paul C. Gilmore et al. (1981). A Discipline In Crisis. ***Communications Of The ACM.*** New York: Association For Computing Machinery, Vol. 24, No. 6, June, 370-374.

Department Of Communications. (1982a). ***Office Communications Systems And Services: A Directory Of Office Automation Equipment And Services.*** Department Of Communications, Ottawa: Supply And Services, 1-100.

———. (1982b). ***The Supply Of Computer Communications Equipment In Canada.*** Communications Canada, Ottawa: Supply And Services, 1-160.

———. (1983). ***The Supply Of And Demand For Computer/Communications Equipment.*** Ottawa: Economics And Marketing Analysis Division, Communications Canada, December, 1-39.

———. (1984). ***Trying Out The Future: Office Communications Systems In The Federal Government.*** Ottawa: Department Of Communications, 1-25.

———. (1985). ***Annual Report 1983/84.*** Ottawa: Supply And Services.

Dermer, Jerry. (1983). Technological Leverage: Benefits, Investments And Risks. ***Business Quarterly: Canada's Management Journal.*** London: University Of Western Ontario, Vol. 48, No. 2, Summer, 124-129.

Dessureaux, Charles H. (1984). April Cube Conference. l'Éducation CIG Québec, l'Éducation B-1000 Réseau. manuscript inédit, Ste-Foy: Gestion du Réseau l'Informatique Des Commissions Scolaires.

Dickson, David. (1984). Europeans Look IBM Gift Horse In The Mouth. ***Science.*** Washington: American Association For The Advancement Of Science. Vol. 226, No. 4670, October 5, 27-28.

Digital Equipment Of Canada Ltd. (1984). ***Annual Review 1984.*** Kanata: Digital Equipment, 1-28.

Dixon, P. J. (1978). Planning MIS Investment And Expense Levels. ***Information And Management.*** Vol. 1, Amsterdam: North Holland, 173-175.

Doctorow, E. L. (1977). False Documents. ***American Review 26: The Magazine Of New Writing.*** No. 26, November, Toronto: Bantam Books, 215-232.

Downing, Hazel. (1981). Word Processors And The Oppression Of Women. ***The Complete Guide To The New Technology And Its Impact On Society.*** (ed) Tom Forester, Cambridge: Massachusetts Institute Of Technology, 257-287.

Downs, Cal W., G. Paul Smeyak & Ernest Martin. (1980). ***Professional Interviewing.*** New York: Harper & Row.

Doyle, Denzil J. (1985). Computer Industry. ***The Canadian Encyclopedia.*** Edmonton: Hurtig Publishers, Volume I, 393-394.

Economist. (1985). Minding Everybody Else's Business: IBM In The Akers Era. ***The Economist.*** London: Economist Newspaper Ltd., Vol. 295, No. 7392, May 4-10, 65-68.

Educational Research Institute Of British Columbia. (1985). ERIBC Test Scoring And Reporting. ***Edge.*** Vancouver: ERIBC, Vol. 12, No. 3, January, 1.

Ein-Dor, Phillip. (1985). Grosch's Law Re-visited: CPU Power And The Cost Of Computation. ***Communications Of The ACM.*** New York: Association For Computing Machinery, Vol. 28, No. 2, February, 142-151.

Ein-Dor, Phillip & Eli Segev. (1978). Centralization, Decentralization And Management Information Systems. ***Information & Management.*** Elsevier: North Holland, Vol. 2, 169-172.

Eisner, Elliot W. (1981). On The Differences Between Scientific And Artistic Approaches To Qualitative Research. ***Educational Researcher.*** Washington: American Educational Research Association, Vol. 10, No. 4, April, 5-9.

Ellen, R. R. (1984). ***Ethnographic Research: A Guide To General Conduct.*** Toronto: Academic Press.

Emery, F. E. (ed). (1981). ***Systems Thinking—Volume One.*** Harmondsworth: Penguin.

———. (1981). ***Systems Thinking—Volume Two.*** Harmondsworth: Penguin.

Emery, T. (ed). (1983). ***Computers In Ontario Education.*** Final Report Of The Provincial Advisory Committee On Computers In Education. Toronto: Ontario Ministry Of Education, 1-134.

Eres, B. K. (1983). Information Technology: Status, Trends And Implications: Part 1. ***Electronic Publishing Review.*** Oxford: Learned Information Ltd., Vol. 3, No. 3, Sept., 223-243.

ERIBC. *see Educational Research Institute Of British Columbia.*

Fader, Stephen. (1983). Mistake To Sell Systems Corporation. ***The Vancouver Sun.*** Vancouver: Pacific Press, Dec. 5, A5.

Fesler, James W. (1968). Centralization And Decentralization. ***International Encyclopedia Of The Social Sciences.*** (ed) David L. Sills, New York: Crowell Collier & MacMillan, Vol. 2, 370-378.

Fisher, Franklin M., James W. McKie & Richard B. Mancke. (1983). ***IBM And The U.S. Data Processing Industry: An Economic History.*** New York: Praeger.

Fishman, Katherine Davis. (1981). ***The Computer Establishment.*** New York: Harper & Row.

Fleming, Jack R. & Barry D. Anderson. (1984). ***Financial Management Of Education In British Columbia: A Background Paper.*** Victoria: British Columbia Ministry of Education, 1-53.

Forest, Al. (1984). Systems Corp.: $60-million Offer. ***Times-Colonist.*** Victoria: Canadian Newspapers, September 12, B 1.

Forester, Tom. (ed). (1985). ***The Information Technology Revolution.*** Oxford: Basil Blackwell.

Fortune. (1981). ***DDP Decisions: A Study Of Decisions To Distribute Data Processing Operations In Major Corporations.*** New York: Fortune, 1-43.

Foster, Peter. (1984). The World According To IBM. ***Saturday Night.*** Toronto: Saturday Night Publications, Vol. 99, No. 7, July, 22-28.

Frantzich, Stephen E. (1982). ***Computers In Congress.*** Managing Information, Vol. 4, Beverly Hills: Sage.

Freeman, Raoul J. (1982). SDS—An Innovative Student Data System. ***AEDS Journal.*** Washington: Association For Educational Data Systems, Vol. 16, No. 1, Fall, 16-45.

———. (1983). A Distributed Processing Approach To Payroll Time Reporting For A Large School District. ***AEDS Journal.*** Washington: Association For Educational Data Systems, Vol. 16, No. 3, Spring, 196-201.

Fulford, Robert. (1970). Against The War Measures Act. ***Saturday Night.*** Toronto: Saturday Night Publications, Vol. 85, No. 12, 11-13.

Galbraith, John Kenneth. (1978). ***The New Industrial State.*** 3rd ed., revised, Boston: Houghton Mifflin.

Garetz, Mark. (1985). Evolution Of The Microprocessor: An Informal History. ***Byte: The Small Systems Journal.*** Peterborough: McGraw-Hill, Vol. 10, No. 9, September, 209-215.

Garfield, Eugene, Henry Small & George Vladitz. (1986). Book review of *Scientific Communication And Information Exchange* by A. I. Mikailove et al. ***Nature.*** London: MacMillan Journals, Vol. 319, No. 6051, January 23-29, 272.

Garms, Walter, James W. Guthrie & Lawrence Pierce. (1978). ***School Finance: The Economics And Politics Of Public Education.*** Englewood Cliffs: Prentice-Hall.

Garson, David G. (1983). Microcomputer Applications In Public Administration. ***Public Administration Review.*** Washington: American Society For Public Administration, Vol. 43, No. 5, Sept.-Oct., 453-458.

Gatley, Wayne. (1984). Microcomputer Use In Elementary School Administration. unpublished manuscript, Vancouver: University Of British Columbia, 1-81.

Gerwin, Donald. (1969). ***Budgeting Public Funds: The Decision Process In An Urban School District.*** Madison: University Of Wisconsin Press.

Gillis, Lynette. (1984). ***A Formative Evaluation Plan For Exemplary Software.*** Toronto: TVOntario, 1-40.

Gilmore, Paul C. (1977). Educational Relevance For Future Employer Or Future Employee? ***Educating For Careers: Policy Issues In A Time Of Change.*** (eds) Thomas F. Powers & John R. Swinton, University Park: Pennsylvania State University Press, 26-31.

Ginzberg, Michael J. (1979). Improving MIS Project Selection. ***Omega: The International Journal Of Management Science.*** Exeter: Pergamon, Vol. 7, No. 6, November, 527-537.

Gisel, G. R. (1979). ***Lower Mainland School District Computer Needs.*** Vancouver: British Columbia Ministry Of Education, Science And Technology.

Giuliano, Vincent E. (1982). The Mechanization Of Office Work. ***Scientific American.*** New York: Scientific American Inc., Vol. 247, No. 3, September, 149-164.

Globe And Mail. (1984). Province Seeks Way To Bury Body Of B.C. Systems Corp. ***Globe And Mail.*** National Edition, Vancouver: Canadian Newspapers, April 24, BC1.

Goldberg, Albert L. (1978). Information Systems Analysis And Design [Observed From Field Experience]. ***AEDS Journal.*** Washington: Association For Educational Data Processing, Vol. 11, No. 3, Spring, 84-96.

Goodlad, John I. (1983). ***A Place Called School: Prospects For The Future.*** Montreal: McGraw-Hill.

Gorden, Raymond L. (1975). ***Interviewing: Strategy, Techniques And Tactics.*** Georgetown: Dorsey.

Gotlieb, Calvin C. (1985). ***The Economics Of Computers: Costs, Benefits, Policies, And Strategies.*** Englewood Cliffs: Prentice-Hall.

Gotlieb, Calvin C. & Z. P. Zeman. (1980). ***Towards A National Computer And Communications Policy: Seven National Approaches*** Toronto: Institute For Research On Public Policy.

Grace, Gerald (ed). (1984). ***Education And The City: Theory, History And Contemporary Practice.*** Boston: Routledge & K. Paul.

de Grazia, Alfred. (1964). Centralization. ***A Dictionary Of The Social Sciences.*** (eds) Julius Gould & Willm L. Kolb, Toronto: Collier-MacMillan, 81-82.

Greer, Ruth Nancy. (1985). Chris Slade Spearheads Innovation In British Columbia's Public Sector. ***CIPS Review/La Revue ACI.*** Toronto: Canadian Information Processing Society, Vol. 9, No. 3, May-June, 3-4.

Gremillion, Lee & Philip Pyburn. (1983). Breaking The Systems Development Bottleneck. ***Harvard Business Review.*** Boston: Harvard, Vol. 61, No. 2, March-April, 130-137.

Grindlay, Andrew. (1981). Systems Analysts: Where Do They Come From Where Do They Go? ***Business Quarterly.*** London: University Of Western Ontario, Vol. 46, No. 1, Spring, 15-17.

———. (1982). Systems Planning: Outside In Or Inside Out? ***Business Quarterly.*** London: University Of Western Ontario, Vol. 47, No. 1, Spring, 69-74.

Gronn, Peter C. (1983). Talk As The Work: The Accomplishment Of School Administration. ***Administrative Science Quarterly.*** Ithaca: Cornell Graduate School Of Business & Public Administration, Vol. 28, No. 1, March, 1-21.

Gross, Bertram M. (1969). The New Systems Budgeting. ***Public Administration Review.*** Washington: American Society For Public Administration, Vol. 29, No. 2, March-April, 113-137.

Grusec, T. (1982). ***A Case Study In Managing Technology Transitions: Replacing Older Machines With Newer, More Efficient, But Functionally Similar Machines.*** Ottawa: Department Of Communications, Vol. 4, Behavioural Research In Office Communications, 1-35.

Guba, Egon G. (1981). Criteria For Assessing The Trustworthiness Of Naturalistic Inquiries. ***Educational Communication And Technology.*** Washington: Association For Educational Communications And Technology, Vol. 29, No. 2, Summer, 75-91.

Guba, Egon & Yvonna S. Lincoln. (1981). ***Effective Evaluation.*** San Francisco: Jossey-Bass.

Halberstam, David. (1969). ***The Best And The Brightest.*** New York: Random House.

Handy, Charles B. (1981). ***Understanding Organizations.*** Harmondsworth: Penguin.

Hansard. *see British Columbia. Debates Of The Legislative Assembly.*

Hansen, Thomas, Daniel Klassen & James Lindsay. (1978). The Impact Of Computer-Based Information Systems Upon School And School District Administration. ***AEDS Journal.*** Washington: Association For Educational Data Systems, Vol. 12 No. 1, Fall, 1-10.

Harrington, Michael. (1980). ***Decade Of Decision: The Crisis Of The American System.*** New York: Simon & Schuster.

———. (1984). ***The New American Poverty.*** New York: Holt, Rinehart & Winston.

Hartle, Douglas G. (1976). Techniques And Processes Of Administration. ***Canadian Public Administration.*** Toronto: The Institute Of Public Administration Of Canada, Vol. 19, No. 1, Spring, 21-33.

Heilbroner, Robert. (1984). Reflections: The Deficit. ***The New Yorker.*** New York: The New Yorker Magazine, Vol. 60, No. 24, July 30, 47-55.

Heinrich, Jack. (1983). Why Provincial Examinations? ***B.C. Teacher.*** Statement By The Minister Of Education, Vancouver: B.C. Teachers' Federation, Vol. 63, No. 2, Nov.-Dec., 59-60.

———. (1985). The Chronology Of Delta's Overspending Trustees. ***Times-Colonist.*** Victoria: Canadian Newspapers, March 7, A-2.

———. (1985). ***Address To The 1985 Annual General Meeting Of The B.C. School Trustees Association By The Minister Of Education.*** Vancouver: BCSTA, May 4, 1-11.

Heise, D. R. & R. G. Simmons. (1985). Some Computer-Based Developments In Sociology. ***Science.*** Washington: American Association For The Advancement Of Science, Vol. 228, No. 4698, April 26, 428-433.

Henderson, Verne E. (1982). The Ethical Side Of Enterprise. ***Sloan Management Review.*** Cambridge: Massachusetts Institute Of Technology, Vol. 23, No. 3, Spring, 37-47.

Herriott, Robert E. & William A. Firestone. (1983). Multisite Qualitative Policy Research: Optimizing Description And Generalizability. ***Educational Researcher.*** Washington: American Educational Research Association, Vol. 12, No. 2, February, 14-19.

Hice, G. F., W. S. Turner & L. F. Cashwell. (1978). ***System Development Methodology.*** Amsterdam: North Holland.

Higgins, John A. & Joseph S. Glickauf. (1954). Electronics Down To Earth. ***Harvard Business Review.*** Cambridge: Harvard University, Vol. 32, No. 2, March-April, 97-104.

Hirsch, Werner Z. (1967). Education In The Program Budget. ***Program Budgeting.*** (ed) D. Novick, Cambridge: Rand Corporation, 178-207.

Hodge, Bartow, Robert A. Fleck & C. Brian Honess. (1984). ***Management Information Systems.*** Reston: Prentice-Hall.

Horowitz, Irving Louis. (1984). ***Winners And Losers: Social And Political Polarities In America.*** Durham: Duke Press.

Houze, William, C. (1983). The Electronic Imperative: Process Information Intelligently Or Perish. ***IEEE Transactions On Professional Communication.*** New York: The Institute Of Electrical And Electronic Engineers Inc., Vol. PC-26, No. 1, March, 38-41.

Howe, Robert L. & Jack R. Totheroh. (1969). ***A Plan For Establishing A Regional Educational Data Processing Centre In The Metropolitan Vancouver Area And Recommendations For An Information System In British Columbia.*** Vancouver: Educational Research Institute Of British Columbia, 1-46.

Howlett, Karen. (1985). IBM Canada Works Hard To Automate Giant's Own Method Of Doing Business. ***Globe And Mail.*** Toronto: Canadian Newspapers, November 21, C8.

Huff, Sid L. (1983). The Future Of Data Processing: The Data Utility. ***Business Quarterly: Canada's Management Journal.*** London: University Of Western Ontario, Vol. 48, No. 2, Summer, 53-57.

Hughes, David G. (1983). Computerized Sales Management. ***Harvard Business Review.*** Boston: Harvard, Vol. 61, No. 2, March-April, 102-112.

Hume, Jim. (1985). Report On B.C. Financial Administration Lacks Humanity. ***Times-Colonist.*** Victoria: Canadian Newspapers Ltd., June 8, A5.

Humphreys, E. H. (1980). ***Privacy In Jeopardy: Student Records In Canada.*** Toronto: Ontario Institute For Studies In Education.

Hunter Beverly, Leroy Finkel et al (eds). (1984). ***Guide To Learning: Resources For Users Of IBM Personal Computers.*** Dayton: International Business Machines.

Huntington, Fred. (1983). The Microcomputer In The Administrative Office. ***AEDS Journal.*** Washington: Association For Educational Data Systems, Vol. 17, No. 1, 91-97.

IBM. *see International Business Machines Corporation*

Illingworth, Valerie (ed). (1983). ***Dictionary Of Computing.*** Oxford: Oxford University Press.

ILO. *see International Labour Organization.*

International Business Machines Corporation. (1958). Faster Punched Card Input-Output For IBM 650. ***Data Processing Systems.*** Toronto: IBM, 1-4.

———. (1960). New Additions To IBM 1401 Data Processing System. ***Technical Information.*** White Plains: IBM, October 20, 1-7.

———. (1961). New Feature Increases Card Reading Performance Of IBM 1401 Computer. ***Technical Information.*** White Plains: IBM, July 3, 1-4.

———. (1963a). Monitor Program And Printer Announced For Use With 1620 Data Processing System. ***Technical Information.*** White Plains: IBM, May 6, 1-2, (includes Fact Sheet: The IBM 1620 Data Processing System, 1-4, provenance unknown).

———. (1984a). ***IBM System/36 — Executive Overview.*** Rochester: IBM, 1-43.

———. (1984b). ***IBM System/38.*** Rochester: IBM, February, 8th ed., 1-179.

———. (1984c). ***Doing Business With IBM: Information Processing Machines And Software.*** Markham: IBM Canada Ltd., 1-4.

———. (1985). ***Systems Network Architecture. Concepts And Products.*** Research Triangle Park: IBM, 3rd ed., 1-62.

International Data Corporation (Canada) Limited. (1985). ***1985 Canadian Personal Computer Markets And Forecasts.*** Toronto: IDC, 1-60.

International Institute For Strategic Studies. (1984). ***The Military Balance.*** 1979-80 to 1984-85, inclusive, London: International Institute For Strategic Studies.

International Labour Organization. (1985). ***The Socio-Economic Impact Of New Technologies.*** Geneva: International Labour Organization, Volume II, Advisory Committee On Technology, First Session, 15-19 April, 1-61.

Jackson, H. L. W. (ed). (1981). ***Teaching Informatics Courses: Guidelines For Trainers And Educationalists.*** New York: North-Holland, Proceedings Of The IFIP WG 3 Working Conference, 1981.

Jeroski, Sharon, Catherine Tolsma & George Labercane. (1984). ***The 1984 B.C. Reading Assessment: Summary Report.*** Victoria: British Columbia Ministry Of Education, September, 1-88.

Jick, Todd D., (1983). Mixing Qualitative And Quantitative Methods: Triangulation In Action. ***Qualitative Methodology.*** (ed) John Van Maanen, Beverly Hills: Sage, 135-148.

Johnson, A. W. (1973). Planning, Programming, And Budgeting In Canada. ***Public Administration Review.*** Washington: American Association For Public Administration, Vol. 33, No. 1, Jan.-Feb., 23-31.

Johnston, Robert D. (1980). Evaluating Computer System Financing Alternatives For Educational Organizations. ***AEDS Journal.*** Washington: Association For Educational Data Systems, Vol. 13, No. 4, Summer, 249-259.

Joyce, John D. & David R. Warn. (1983). Human Factors Aspects Of A Modern Data Base System. ***Information And Management: The International Journal Of Information Systems Applications.*** Amsterdam: Elsevier, Vol. 6, No. 1, February, 27-36.

Kalt, Helmut. (1983). Videotex—Computer Power For All. ***Siemens Review.*** Berlin: Siemens Aktiengesellschaft, Vol L, Nov.-Dec. 18-21.

Katz, Daniel, Barbara A. Gutek, Robert Kahn et al. (1975). ***Bureaucratic Encounters: A Pilot Study In The Evaluation Of Government Services.*** Ann Arbor: Institute For Social Research, University Of Michigan.

Kelk, Douglas. (1985a). Ministry Studying School Board Claim. ***Times Colonist.*** Victoria: Canadian Newspapers, January 9, B1.

———. (1985b). Island Boards Join Restraint Defiance. ***Times-Colonist.*** Victoria: Canadian Newspapers, No. 65, February 15, A1.

Kesselman, Jonathan R. (1984). ***Should The British Columbia Government Pursue Mini-Efficiency Or Social Efficiency?*** Vancouver: British Columbia Economic Policy Institute, Paper No. P-84-10, June, 1-21.

Keyes, Robert W. (1985). What Makes A Good Computer Device? ***Science.*** Washington: The American Association For The Advancement Of Science, Vol. 230, No. 4722, October 11, 138-144.

King, John Leslie. (1982). Local Government Use Of Information Technology: The Next Decade. ***Public Administration Review.*** Washington: American Society For Public Administration, Vol. 42, No. 1, Jan.-Feb., 25-36.

Kirby, A. J. (1983a). Quebec School Boards Initiate The World's Largest Educational Network. ***Creative Solutions In Industry.*** Burroughs Canada, February, 1-4.

———. (1983b). Quebec's Community Colleges Standardize On Burroughs For Student/Administrative Work. ***Creative Solutions In Industry.*** Don Mills: Burroughs Canada, July, 1-4.

Kleijnen, J. P. C. (1979). Evaluation Of Management Information Systems. ***Omega: The International Journal Of Management Science.*** Exeter: Pergamon, Vol. 7, No. 6, November, 539-543.

Knezevich, Stephen J. (1981). Program Budgeting Revisited: Reexamining Its Promise For The Enhancement Of Education During The 1980's. ***The Executive Review.*** Vol. 2, No. 1, October, Institute For School Executives, Iowa.

———. (1984). ***Administration Of Public Education.*** 4th ed., New York: Harper & Row.

Kochen, Manfred, & Karl W. Deutsch. (1980). ***Decentralization: Sketches Toward A Rational Theory.*** Cambridge: Oelgeschlager, Gunn & Hain.

Kosecoff, Jacqueline & Arlene Fink. (1982). ***Evaluation Basics: A Practitioner's Manual.*** Beverly Hills: Sage.

Kozol, Jonathan. (1985). ***Illiterate America.*** New York: Anchor Press/Doubleday Garden City.

Kraemer, Kenneth L. & John Leslie King. (1976). ***Computers, Power, And Urban Management: What Every Local Executive Should Know.*** Beverly Hills: Sage.

———. (1977a). ***Computers And Local Government: A Manager's Guide*** Vol. I. New York: Praeger.

———. (1977b). ***Computers And Local Government: A Review Of The Research*** Vol. II. New York: Praeger.

Kraemer, Kenneth L., William H. Dutton & Alana Northrop. (1981). ***The Management Of Information Systems.*** New York: Columbia University.

Kroeber, Donald W., Hugh J. Watson & Ralph H. Sprague, Jr. (1980). An Empirical Investigation And Analysis Of The Current State Of Information Systems Evolution. ***Information & Management.*** Amsterdam: Elsevier, Vol. 3, No. 1, February, 35-43.

Kuttner, Bob. (1983). Sweden/Denmark: Trials Of Two Welfare States. ***Atlantic Monthly.*** Boston: Atlantic Monthly Co., Vol. 252, No. 5, November, 14-22.

———. (1983). The Declining Middle. ***Atlantic Monthly.*** Boston: Atlantic Monthly Co., Vol. 252, No. 1, July, 60-72.

Land, F. F. (1980). A Critical View Of Some Recent Assertions About MIS And DBMS. ***Information & Management.*** Amsterdam: North Holland, Vol. 3, No. 4, October, 129-131. 129-131.

La Noue, George R. & Bruce L. Smith. (1973). ***The Politics Of School Decentralization.*** Toronto: Lexington.

Large, Peter. (1984). ***The Micro Revolution Revisited.*** London: Frances Pinter.

Larkey, Patrick D. & Richard A. Smith. (1984). The Misrepresentation Of Information In Government Budgeting. ***Advances In Information Processing In Organizations.*** Vol. 1, (eds) Lee S. Sproull & P. D. Larkey, London: JAI, 63-92.

Lasswell, Harold D. (1971). Policy Problems Of A Data-Rich Civilization. ***Information Technology In A Democracy.*** (ed) Alan F. Westin, Cambridge: Harvard Press, 187-197.

Latorre, Ronald. (1985). ***A Comparison Of The Programs And Services Available To Schools During The 1983-84 And 1984-85 School Years.*** Vancouver: Vancouver School Board, January 23, 1-54.

Laubach, Peter B. & Lawrence E. Thompson. (1955). Electronic Computers: A Progress Report. ***Harvard Business Review.*** Cambridge: Harvard University, Vol. 33, No. 2, March-April, 120-130.

Laudon, Kenneth C. (1974). ***Computers And Bureaucratic Reform: The Political Functions Of Urban Information Systems.*** Toronto: John Wiley & Sons.

———. (1976). Computers And Cultural Imperatives. (Review of Abbe Moshowitz's Conquest Of Will). ***Science.*** Washington: American Association For The Advancement Of Science, Vol. 193, No. 4258, 17 September, 1111-1112.

Leavitt, Harold J. & Thomas L. Whisler. (1958). Management In The 1980's. ***Harvard Business Review.*** Cambridge: Harvard University, Vol. 36, No. 6, Nov.-Dec., 41-48.

LeCompte, Margaret D. & Judith Preissle Goetz. (1982). Problems Of Reliability And Validity In Ethnographic Research. ***Review Of Educational Research.*** Washington: American Educational Research Association, Vol. 52, No. 1, Spring, 31-60.

Lee, Robert D., Jr. & Ronald Johnson. (1983). ***Public Budgeting Systems.*** 3rd ed. Baltimore: University Park Press.

Leiren, Hall. (1976). Bennett Plans To Set Up Computer Corporation. ***Vancouver Sun.*** Vancouver: Pacific Press, Oct. 7, 76.

Leontief, Wassily F. (1982). The Distribution Of Work And Income. ***Scientific American.*** New York: W. H. Freeman, Vol. 247, No. 3, September, 188-204.

Levin, Melvin R. (1977). ***Community And Regional Planning.*** New York: Praeger.

Lindblom, Charles E. (1959). The Science Of "Muddling Through". ***Public Administration Review.*** Washington: American Society For Public Administration, Vol. 12, No. 2, 79-88.

———. (1968). ***The Policy-Making Process.*** Englewood Cliffs: Prentice-Hall.

Longley, Dennis & Michael Shain. (1982). ***Dictionary Of Information Technology.*** London: MacMillan.

Lowi, Theodore J. (1980). The Political Impact Of Information Technology. ***The Complete Guide To The New Technology And Its Impact On Society.*** (ed) Tom Forester, Cambridge: Massachusetts Institute Of Technology, 257-287.

Lu, Cary. (1984). Integrated Software Bids For Centre Stage: Complex New Programs Pose Difficult Design Questions. ***High Technology.*** Boston: HiTech Publishing, Vol. 4, No. 11, November, 32-34.

Lucas, Henry C. (1978). ***Information Systems Concepts For Management.*** New York: McGraw-Hill.

Lucas, Henry C., Jr. (1984). Organizational Power And The Information Services Department. ***Communications Of The ACM.*** New York: Association For Computing Machinery Inc., Vol. 27, No. 1, January, 58-65.

Lucas, Henry C. & Jon A. Turner. (1983). A Corporate Strategy For The Control Of Information Processing. ***Sloan Management Review.*** Cambridge: Massachusetts Institute Of Technology, Vol. 23, No. 3, Spring, 25-36.

MacDonald, B. A. (1973). Program Budgeting In The Government Of Canada: Origin And Progress. ***Current Practice In Program Budgeting (PPBS): Analysis And Case Studies Covering Government And Business.*** David Novick (ed), New York: Rand Corporation.

Macfarlane, David. (1983). What You Get When You Buy Office Automation. ***Datamation.*** New York: Technical Publishing Co., Vol. 29, No. 2, February, 102-114.

Machlup, Fritz. (1962). ***The Production And Distribution Of Knowledge In The U.S. Economy.*** Princeton: Princeton University Press.

———. (1980). ***Knowledge And Knowledge Production.*** Princeton: Princeton University Press, Knowledge: Its Creation, Distribution, And Economic Significance, Vol. I.

———. (1982). ***The Branches Of Learning.*** Princeton: Princeton University Press, Knowledge: Its Creation, Distribution, And Economic Significance. Vol. II

———. (1984). ***The Economics Of Information And Human Capital.*** Princeton: Princeton University Press, Vol. III, Knowledge: Its Creation, Distribution, And Economic Significance.

Maclean, Susan. (1985). Information Processors Challenged: Heed Your Social Conscience. ***CIPS Review/La Revue ACI.*** Toronto: Canadian Information Processing Society, Vol. 9, No. 4, July-Aug. 6-7.

Magnusson, Warren, Monika Langer. (1984). The "New Reality" In Education. ***The New Reality: The Politics Of Restraint In British Columbia.*** Warren Magnusson, William Carroll et al. (eds), Vancouver: New Star Books.

Manitoba Department Of Education. (1984). Educational Technology Program: An Overview. unpublished manuscript, Winnipeg: Manitoba Department Of Education, 1-3.

Marshall, David G. (1982). Purchasing A Microprocessor System For Administrative Use In Schools. ***AEDS Journal.*** Washington: Association For Educational Data Systems, Vol. 15, No. 4, Summer, 183-197.

McFarlan, Warren F., James L. McKenney, & Philip Pyburn. (1983). The Information Archipelago - Plotting A Course. ***Harvard Business Review.*** Boston: Harvard, Vol. 61, No. 1, Jan.-Feb., 145-156.

McKenney, James L. & Warren F. McFarlan. (1982). The Information Archipelago - Maps And Bridges. ***Harvard Business Review.*** Boston: Harvard, Vol. 60, No. 5, Sept.-Oct., 109-119.

McLean, Robert S. (1983). ***Ontario Ministry Of Education: Specifies Its Microcomputer.*** Toronto: Ontario Institute For Studies In Education, 1-16.

Medows, A. J., M. Gordon & A. Singleton. (1982) ***Dictionary Of New Information Technology.*** London: Kogan Page.

Meek, Brian. (1984). Towards The 21st Century. ***New Information Technology.*** (ed) Alan Burns, Toronto: John Wiley, 216-235.

Meldman, Jeffrey A. (1982). Educating Toward Ethical Responsibility In MIS. ***Sloan Management Review.*** Cambridge: Massachusetts Institute Of Technology, Vol. 23, No. 2, Winter, 73-75.

Melone, Nancy Paule. (1984). A Strategy For Knowledge-Based Decision Support: Decision Making Expertise In Computer Acquisitions. unpublished manuscript, University Of Minnesota, 1-54.

Mendes, Kathleen S. (1980). Structured Systems Analaysis: A Technique To Define Business Requirements. ***Sloan Management Review.*** Cambridge: Massachusetts Institute Of Technology, Vol. 21, No. 4, Summer, 51-63.

Menzies, Heather. (1981). ***Women And The Chip: Case Studies Of The Effects Of Informatics On Employment In Canada.*** Montreal: Institute For Research On Public Policy.

Meyer, Dean N. (1983). The Office Automation Cookbook: Management Strategies For Getting Office Automation Moving. ***Sloan Management Review.*** Cambridge: Massachusetts Institute of Technology, Vol. 24, No. 2, Winter, 51-60.

Miles, Matthew B. & A. Michael Huberman. (1984). ***Qualitative Data Analysis: A Sourcebook Of New Methods.*** Sage: Beverly Hills.

Millar, Victor E. (1983). Decision-Oriented Information. ***Datamation.*** New York: Technical Publishing Co., Vol. 30, No. 1, January, 159-162.

Minsky, Marvin L. (1979). Computer Science And The Representation Of Knowledge. ***The Computer Age: A Twenty-Year View.*** (eds) Michael L. Desfouzeaus & Joel Moses, Cambridge: Massachusetts Institute Of Technology, 392-421.

Mood, Alexander M. (1983). ***Introduction To Policy Analysis.*** New York: North-Holland.

Morvan, Pierre. (1981). ***Dictionnaire De L'Informatique.*** Paris: Larousse.

Mosher, Frederick C. (1969). Limitations And Problems Of PPBS In The States. ***Public Administration Review.*** Washington: American Society For Public Administration, Vol. 29, No. 2, March-April, 160-167.

Moto-oka, Tohru. (1984). Fifth Generation Computers And Very Large Scale Integration. ***Endeavour.*** Oxford: Pergamon, Vol. 13, No. 2, 95-100.

Mowshowitz, Abbe. (1976). ***The Conques: Of Will: Information Processing In Human Affairs.*** Reading: Addison-Wesley.

Mueller, Eva, Judith Hybels et al. (1969). ***Technological Advance In An Expanding Economy: Its Impact On A Cross-Section Of The Labor Force.*** Ann Arbor: Institute For Social Research, University Of Michigan.

Mumford, Enid. (1981). ***Values, Technology And Work.*** London: Martinus Nijhoff.

National Centre For Educational Statistics. (1982). ***Projection Of Educational Statistics To 1990-91, Volume I: Analytical Report.*** (eds) Martin M. Frankel & Debra E. Gerded, Washington: National Centre For Educational Statistics.

Neogi, Prabir. (1985). Census Allows Analysis Of Growth, Trends From 1980-84. ***CIPS Review/La Revue ACI.*** Toronto: Canadian Information Processing Society, Vol. 9, No. 2, March-April, 10-14.

Neumann, Seev & Eli Segev. (1980). Evaluate Your Information System. ***Journal Of Systems Management.*** Cleveland: Association Of Systems Management, Vol. 31, No. 3, March, 34-41.

New Scientist. (1985). Computer Talk. ***New Scientist.*** London: New Science Publications, Vol. 107, No. 1475, September 26, 84.

Nolan, Richard L. (1979). Managing The Crises In Data Processing. ***Harvard Business Review.*** Boston: Harvard, Vol. 57, No. 2, March-April, 115-126.

———. (1982). Managing Information Systems By Committee. ***Harvard Business Review.*** Boston: Harvard, Vol. 60, No. 5, Sept.-Oct., 72-79.

Nora, Simon & Alain Minc. (1980). ***The Computerization Of Society: A Report To The President Of France.*** Cambridge: Massachusetts Institute Of Technology.

Northrop, Alana, William H. Dutton & Kenneth L. Kraemer. (1982). The Management Of Computer Applications In Local Government. ***Public Administration Review.*** Washington: American Society For Public Administration, Vol. 42, No. 3, May-June, 234-243.

Novick, David. (1973). Brief History Of Program Budgeting. ***Current Practice In Program Budgeting (PPBS): Analysis And Case Studies Covering Government And Business.*** (ed) David Novick, New York: Crane, Russak, 19-28.

Oberlyn, Ros. (1982). Officials Get New Computers. ***Vancouver Sun.*** Vancouver: Pacific Press, May 7, A10.

Oettinger, Anthony G. (1969). ***Run, Computer Run: The Mythology Of Education Innovation.*** Cambridge Harvard University Press.

Ogilvie, Jean. (1981). ***Educational Computing In Canada.*** Report To The Inter Development Research Centre, Ottawa. Social Sciences Division, August.

O'Higgins, Michael. (1984). Computerizing The Social Security System: An Operational Strategy In Lieu Of A Policy Strategy? ***Public Administration.*** Oxford: Royal Institute Of Public Administration, Vol. 62, No. 2, Summer, 201-210.

Omang, Joanne. (1982). The Secret Handicap: Millions Of American Adults Can't Read. ***The Washington Post.*** Washington: Donald E. Graham, November 25, 1.

Ontario. (1969). ***Effective Management Through PPBS.*** Toronto: Treasury Board.

Ontario Ministry Of Education. (1983a). ***Functional Requirements For Microcomputers For Educational Use In Ontario Schools—Stage I.*** Toronto: Ontario Ministry Of Education, March, 1-25.

———. (1983b). ***The Icon—Ontario's Own Microcomputer.*** November, 1-5.

Ören, Tuncer I., Janusz A. Brzozowski, & Paul C. Gilmore. (1983). Solving The Crisis In Academic Computer Science. ***CIPS Review/La Revue ACI.*** Toronto: Canadian Information Processing Society, Vol. 7, No. 2, 24-26.

Osborn, Roddy F. (1954). GE And Univac: Harnessing The High-Speed Computer. ***Harvard Business Review.*** Cambridge: Harvard University, Vol. 32, No. 4., July-Aug., 99-107.

Otto, Wayne, Anne Wolf & Roger G. Eldridge. (1984). Managing Instruction. ***Handbook Of Reading Research.*** (ed) P. David Pearson, New York: Longman Inc., 799-828.

Owens, Robert G. (1982). Methodological Perspective: Methodological Rigor In Naturalistic Inquiry: Some Issues And Answers. ***Educational Administration Quarterly.*** New York: University Of Rochester, Vol. 18, No. 2, Spring, 1-21.

Pacey, Arnold. (1983). ***The Culture Of Technology.*** Cambridge: Massachusetts Institute Of Technology.

Pantages, Angeline. (1985). Beyond Today's Blue. ***Datamation.*** New York: Technical Publishing, Vol. 31, No. 11, June 1, 22-32.

Parkin, Andrew. (1980). ***Systems Management.*** London: Edward Arnold, 1980.

Parkinson, D. (1985). Computers: More Parallel Than Others. ***Nature: International Weekly Journal Of Science.*** Basingstoke: MacMillan Journals, Vol. 316, No. 6031, Aug. 29—Sept. 4, 765-766.

Parnas, David Lorge. (1985). Software Aspects Of Strategic Defense Systems. ***American Scientist.*** New Haven: Sigma Xi, The Scientific Research Society, Vol. 73, No. 5, Sept.-Oct., 432-440.

Parsons, Gregory L. (1983). Information Technology: A New Competitive Weapon. ***Sloan Management Review.*** Cambridge: Massachusetts Institute Of Technology, Vol. 25, No. 1, Fall, 3-14.

Perlowski, A. A. (1981). The "Smart" Machine Revolution. ***The Microelectronics Revolution.*** (ed) Tom Forester, Cambridge: Massachusetts Institute Of Technology, 105-124.

Perrow, Charles. (1970). ***Organizational Analysis: A Sociological View.*** Montery: Brooks/Cole.

———. (1972). ***Complex Organizations: A Critical Essay.*** 2nd ed., Glenview: Scott, Foresman.

———. (1984). ***Normal Accidents: Living With High Risk Technologies.*** New York: Basic Books.

Pickup, Carol & Norman Robinson. (1984). ***Lillooet School District Commission Of Inquiry Into Education.*** Vancouver: British Columbia Teachers' Federation, June, 1-38.

Pitt, Douglas C. & Brian C. Smith (eds). (1984). ***The Computer Revolution In Public Administration: The Impact Of Information Technology On Government.*** Brighton: Wheatsheaf Books Ltd.

Poppel, Harvey L. (1982). Who Needs The Office Of The Future? ***Harvard Business Review.*** Boston: Harvard, Vol. 60, No. 6, Nov.-Dec., 146-155.

Powers, Michael J. (1978). Management Information Systems For Academic Administration. ***AEDS Journal.*** Washington: Association For Educational Data Systems, Vol. 11, No. 4, Summer, 97-106.

Quade, E. S. (1982). ***Analysis for Public Decisions.*** 2nd ed. New York: Elsevier.

Québec. (1983a). ***De la Direction de l'Informatique du Ministère de l'Éducation.*** Cahier de Présentation. Ministère de l'Éducation, Gouvernement du Québec, circa 1983, 1-37.

———. (1983b). ***Service de l'Exploitation.*** Ministère de l'Éducation, Montréal: Direction des Services Informatiques Aux Réseaux, 1-19.

———. (1983c). ***Service des Systémes Collectifs.*** Ministère de l'Éducation, Montréal: Gouvernement du Québec, [Direction des Services Informatiques Aux Réseaux], 1-26.

Ragsdale, R. (1982). ***Computers In The Schools: A Guide For Planning.*** Toronto: Ontario Institute For Studies In Education.

———. (1983). Student Records In Ontario: Privacy And The Right To Know— Suggested Policy Guidelines. Toronto: Ontario Ministry Of Education, 1-37.

Ransom, Neill L. (1984). SAM's Progress. ***The Times Educational Supplement.*** London: The Times, No. 3531, 2.3.84, 44-45.

Response Services Incorporated. (1985). ***Software For The IBM/34 and /36, IBM Personal Computer.*** Vancouver: Response Services, 1-21.

Ritter, Richard & James Cutt. (1985). ***The Evolution Of Central Financial Administration In The Government Of British Columbia.*** Victoria: Institute For Research On Public Policy, A Report For The Ministry Of Finance, April, 1-146.

Rochfeld, A. & H. Tardieu. (1983). MERISE: An Information System Design And Development Methodology. ***Information & Management: An International Journal Of Information Systems Applications.*** Amsterdam: Elsevier, Vol. 6, No. 3, June, 143-159.

Rockart, John F. (1982). The Changing Role Of The Information Systems Executive: A Critical Success Factors Perspective. ***Sloan Management Review.*** Cambridge: Massachusetts Institute Of Technology, Vol. 24, No. 1, Fall, 3-13.

Rockart, John F. & Michael E. Treacy. (1982). The CEO Goes On-Line. ***Harvard Business Review.*** Boston: Harvard, Vol. 60, No. 1, Jan.-Feb., 82-88.

Roney, Robert K. & Irma O. Perry. (1976). Computer Assisted Personnel Administration. ***AEDS Journal.*** Washington: Association For Educational Data Systems, Vol. 10, No. 1, Fall, 18-25.

Rosenberg, Richard S. (1984). ***Computers And The Information Society.*** Vancouver: Computer Science Department, University Of British Columbia.

Royal Canadian Mounted Police. (1975-1984). ***EDP Security Bulletin/Sécurité De L'Informatique.*** Ottawa: EDP Security Branch, Vol. 1, No. 1 to Vol. 9, No. 2, inclusive.

———. (1981). ***Security In The EDP Environment.*** Ottawa: 'P' Directorate, Security Systems Branch, Vol. 1, January, 1-16.

———. (1982). ***EDP Threat Assessment: Concepts & Planning Guide.*** Ottawa: 'P' Directorate, Security Systems Branch Vol. 2, January, 1-35.

Royal Commission On Financial Management And Accountability. *see Canada.*

Ruff, Norman J. (1983). Managing The Public Service. ***The Reins Of Power: Governing British Columbia.*** J. T. Morely et al (eds), Toronto: Douglas McIntyre, 161-197.

Rutledge, J. H. (1981). ***OSI And SNA: A Perspective.*** Washington Systems Centre: IBM, 1-43. Sagert, James D. (1982). Computers And Organizational Communications: An Analysis Of Their Implications For Administration. unpublished manuscript, University Of British Columbia, 1-83.

Sale, Barry E. J. (1982). The Application And Utilization Of Microcomputers In British Columbia Secondary Schools. unpublished manuscript, Vancouver: University Of British Columbia, 1-111.

Sanger, David E. (1985). The Changing Image Of I.B.M. ***The New York Times Magazine.*** New York: New York Times, July 7, 12-46.

Saunders, Peter & Friedrich Klau. (1985). ***The Role Of The Public Sector: Causes And Consequences Of The Growth Of Government.*** Paris: Organization For Economic Co-operation And Development, No. 4, Spring.

Scannell, Timothy J. (1981). 'Fortune' Survey Finds No Loss Of Corporate Control In Move To DDP. ***Computerworld.*** Framingham: CW Communications Inc., Vol. 15, No. 12, March 23, 10-11.

Schick, Allen. (1969). Systems Politics And Systems Budgeting. ***Public Administration Review.*** Washington: American Society For Public Administration, Vol. 29, No. 2, March-April, 137-151.

———. (1973). A Death In The Bureaucracy: The Demise Of Federal PPB. ***Public Administration Review.*** Washington: American Society For Public Administration, Vol. 33, No. 2, March-April, 146-156.

Schultze, Charles L. (1968). ***The Politics And Economics Of Public Spending.*** Washington: Brookings Institute.

Schumacher, B. G. (1967). ***Computer Dynamics In Public Administration.*** London: MacMillan.

Schwetz, Roland. (1983). Technology In The Office—Practical Benefits Are The Primary Objectives. ***Siemens Review.*** Aktiengesellshaft, Vol. L, Sept.-Oct., 14-19.

Seidmann, A. & A. Arbel. (1983). An Analytic Approach For Planning Computerized Office Systems. ***Omega: The International Journal Of Management Science.*** Exeter: Pergamon Press, Vol. 11, No. 6, 607-617.

Serafini, Shirley & Michel Andrieu. (1981). ***The Information Revolution And Its Implications For Canada.*** Ottawa: Communications Economics Branch, Department Of Communications, Government Of Canada.

Sheingold, Karen, Janet H. Krane & Mari E. Endreweit. (1983). Microcomputer Use In Schools: Developing A Research Agenda. ***Harvard Educational Review.*** Cambridge: Harvard University, Vol. 53, No. 4, November, 412-432.

Shepard, W. J. (1963). Centralization. ***Encyclopaedia Of The Social Sciences.*** Vol. 3, (ed) Edwin R. Seligman, New York: MacMillan.

Shorris, Earl. (1980). Scenes From Corporate Life: Fifteen Exemplary Tales. ***Harper's.*** New York: Harper's Magazine Co., Vol. 260, No. 1558, March, 45-64.

Silverman, David. (1970). ***The Theory Of Organizations: A Sociological Framework.*** London: Heinemann.

Simair, Denis Jules. (1980). ***The Administrator's Apple Package Programs.*** Victoria: Simair, 1-22.

Simon, Herbert A. (1962). The Architecture Of Complexity. ***Proceedings Of The American Philosophical Society.*** Independence Square: The American Philosophical Society, Vol. 106, No. 6, 467-482.

———. (1965). ***The Shape Of Automation For Men And Management.*** New York: Harper & Row.

———. (1979). The Consequences Of Computers For Centralization And Decentralization. ***The Computer Age: A Twenty-Year View.*** (eds) M. L. Dertouzos & J. Moses, Cambridge: Massachusetts Institute Of Technology, 212-228.

Simon, Herbert A., G. Kozmetsky, H. Guetzkow & G. Tyndall. (1954). Centralization Versus Decentralization In Organizing The Controller's Department. New York: Controllership Foundation Inc.

Simpson, Robert. (1985). 'Onward To Better Things': The Grads-Day Speech That Infuriated A Cabinet Minister. ***Vancouver Sun.*** Vancouver: Southam, August 30, A5.

SIPRI. Stockholm International Peace Research Institute. (1985). ***World Armaments And Disarmament.*** London: Taylor & Francis.

Slater, Robert E. (1958). Thinking Ahead: How Near Is The Automatic Office? ***Harvard Business Review.*** Cambridge: Harvard University, Vol. 36, No. 2, March-April, 27-176.

de Sola Pool, Ithiel. (1983). ***Technologies Of Freedom.*** Cambridge: Harvard University Press.

de Sola Pool, Ithiel, Stuart McIntosh & David Griffel. (1971). Information Systems And Social Knowledge. ***Information Technology In A Democracy.*** (ed) Alan Westin, Cambridge: Harvard University, 241-249.

Spuck, Dennis W. & William C. Bozeman. (1980). A Design For The Evaluation Of Management Information Systems. ***AEDS Journal.*** Washington: Association For Educational Data Systems, Vol. 14, No. 1, Fall, 30-44.

Spuck, Dennis W. & Gene Atkinson. (1983). Administrative Uses Of The Microcomputer. ***AEDS Journal.*** Washington: Association For Educational Data Systems, Vol. 17, No. 1 & 2, Fall & Winter, 83-90.

Statistics Canada. (1980). ***The Labour Force.*** Ottawa: Supply And Services, December.

———. (1985a). ***Advance Statistics Of Education: 1984-85.*** Ottawa: Supply And Services, No. 81-220, February.

———. (1985b). ***Advance Statistics Of Education: 1985:86.*** Ottawa: Supply And Services, No. 81-220, September.

Steiner, George A. (1967). Problems In Implementing Program Budgeting. ***Program Budgeting: Program Analysis And The Federal Budget.*** Cambridge: Rand Corporation.

Sterling, Theodore D. (1967). Humanizing Computerized Information Systems. ***AEDS Journal.*** Washington: Association For Educational Data Systems, Vol. 10, No. 1, Fall, 1-10.

———. (1985). Computers And Society. ***The Canadian Encyclopedia.*** Edmonton: Hurtig Publishers, Volume I, 396-397.

Surtees, Lawrence. (1984). One Out Of Every Two Workers Will Have A PC By 1990. ***The Globe And Mail.*** Toronto: Canadian Newspaper Co. Ltd., October 19, R 1.

Suzuki, David. (1985). Keynote Address. ***AARN Newsletter.*** Edmonton: Alberta Association Of Registered Nurses, Vol. 41, No. 9, October.

Swainson, Neil A. (1983). The Public Service. ***The Reins Of Power.*** Vancouver: Douglas & McIntyre, 119-160.

Sweden. (1979). ***The Vulnerability Of The Computerized Society: Preliminary Report.*** translated by John Hogg, Stockholm: Swedish Ministry Of Defense, Sårbarhetskommittén, LiberFörlag/Allmänna forl, 1-22.

———. (1980). ***The Vulnerability Of The Computerized Society: Considerations And Proposals.*** Stockholm: Swedish Ministry Of Defense, Sårbarhetskommittén, LiberFörlag/Allmänna forl, 1-20.

———. (1984). ***Computers And Changes In Working Life.*** Summary Of Final Report, Commission On The Effects Of Computerization On Employment And Working Environment. Stockholm: Ministry Of Labour, 1-13.

Systems In Education Ltd. (1983). ***Users' Manual For Harts III.*** Vancouver: Harts System Ltd., 1-55.

Talley, Sue. (1983). Selection And Acquisition Of Administrative Microcomputer Software. ***AEDS Journal.*** Washington: Association For Educational Data Systems, Vol. 17, Nos. 1 & 2, Fall & Winter, 69-82.

Telem, Moshe. (1982). CMI And The MIS—An Integration Needed. ***AEDS Journal.*** Washington: Association For Educational Data Systems, Vol. 16, No. 1, Fall, 48-55.

Tetreault, T. P. (1983). Overview Of High Technology In British Columbia. unpublished manuscript, Vancouver: Department Of Communications, Pacific Region, Government Of Canada, September, 1-49.

Thompson, Gordon B. (1979). ***Memo From Mercury: Information Technology Is Different.*** Occasional Paper No. 10, Montreal: Institute For Research On Public Policy, 1-62.

———. (1980). Computing And The Future (Review of Dertouzos and Mozes' The Computer Age). ***Science.*** Washington: American Association For The Advancement Of Science, Vol. 209, No. 4454, 18 July, 384.

Tilborg, Andre W. & Larry Wittie. (1983). Operating Systems For The Micronet Network Computer. ***IEEE Micro.*** New York: Institute Of Electrical And Electronic Engineers, Vol. 3, No. 2, April, 38-40.

Times-Colonist. (1983a). BC Systems: What's Going On? ***Times-Colonist.*** Victoria: Canadian Newspapers, Editorial, September 2, A-4.

———. (1983b). 973 Fewer Teachers. ***Times-Colonist.*** Victoria: Canadian Newspapers, December 28, A-1.

———. (1984a). Delayed Marks Keep University Hopefuls On Edge. ***Times-Colonist.*** Victoria: Canadian Newspapers, August 29, B-11.

———. (1984b). Let Students See How They Fared. ***Times-Colonist.*** Editorial, Victoria: Canadian Newspapers, September 25, A-4.

———. (1984c). Foulup Enriches Students. ***Times-Colonist.*** Victoria: Canadian Newspapers, September 26, A-3.

———. (1984d). Honor Grad Poor Reader. ***Times-Colonist.*** Victoria: Canadian Newspapers, October 18, A-10.

———. (1985). School Board Penalty An "Act Of Vengeance." ***Times-Colonist.*** Victoria: Canadian Newspapers, February 22, A-3.

Tombaugh, Jo W. & Richard F. Dillon. (1982). ***The Design Of User Manuals For Office Systems: A Review Of The Literature.*** Ottawa: Department Of Communications, Vol. 1, Behavioural Research In Office Communications, 1-234.

Turnbull, Malcolm. (1979). B.C. Government Computer Firm Has "Turned Corner". ***The Province.*** Vancouver: Southam News, July 25, 4.

UNESCO. (1984). ***Statistical Yearbook 1984.*** Paris: United Nations Educational, Scientific And Cultural Organization.

United States Bureau Of The Census. (1984). ***Statistical Abstract Of The United States: 1985.*** 105th edition. Washington: U.S. Bureau Of The Census.

Vacroux, André G. (1975). Microcomputers. ***Scientific American.*** New York: W. H. Freeman, Vol. 232, No. 5, May, 32-40.

Vancouver Sun. (1977). Data Process Firms Protest. ***Vancouver Sun.*** Vancouver: Pacific Press, June 22, 44.

———. (1979). Union Strikes B.C. Systems Corp. ***Vancouver Sun.*** Vancouver: Pacific Press, September 26, A 19

———. (1985). Heinrich Fires Trustees: Report Blasts Vancouver School Board. ***Vancouver Sun.*** Vancouver: Pacific Press, May 6, A1.

van Geel, Tyll. (1973). PPBES And District Resource Allocation. ***Administrators Notebook.*** Midwest Administrative Centre, University Of Chicago. Vol. XXII, No. 1.

Van Maanen, John (ed). (1983). ***Qualitative Methodology.*** Beverly Hills: Sage.

Van Maanen, John, James M. Dabbs, Jr. & Robert R. Faulkner. (1982). ***Varieties Of Qualitative Research.*** Beverly Hills: Sage.

Verity, John. (1985). The Shifting Shape Of SNA. ***Datamation.*** New York: Technical Publishing, Vol. 31, No. 22, Nov. 15, 93-98.

Vidal, Gore. (1984). ***Lincoln.*** New York: Random House.

Volkart, Carol & Peter Comparelli. (1985). Delta: No Penalty Warning. ***Vancouver Sun.*** Vancouver: Southam, February 22, A1.

Walker, Alan. (1984). ***Social Planning: A Strategy For Socialist Welfare.*** Oxford: Basil Blackwell.

Webb, L. Dean & Van D. Mueller (eds). (1984). ***Managing Limited Resources: New Demands On Public School Management.*** Fifth American Yearbook Of The American Educational Finance Association, Cambridge: Ballinger Publishing.

Weber, Robert Philip. (1985). ***Basic Content Analysis.*** Beverly Hills: Sage University Papers, 1-93.

Weiss, Ulrich. (1983). Banking Services—New Technologies, New Approaches. ***Siemens Review.*** Berlin: Siemens Aktiengesellschaft, Vol. L, Nov.-Dec. 7, 2-7.

Weizenbaum, Joseph. (1976). ***Computer Power And Human Reason: From Judgement To Calculation.*** San Francisco: W. H. Freeman.

———. (1984). Another View From MIT. ***Byte: The Small Systems Journal.*** Peterborough: McGraw-Hill, Vol. 9, No. 6, June, 225.

Westell, Anthony. (1970). Trudeau — New Style PM, Power And Politics. ***Politics: Canada.*** 3rd ed, (ed) Paul W. Fox, Toronto: McGraw-Hill, 326-328.

Westrom, Marvin. (1982a). Microcomputers In School Administration. ***The Canadian School Executive.*** Edmonton: University Of Alberta, Vol. 2, No. 1, May, 8-10.

———. (1982b). H Is For "Heuristic": HARTS. ***The McGill Journal Of Education.*** Montreal: McGill University, Vol. 18, No. 3, Fall, 244-252.

Wiederhold, Gio. (1983). Modeling Databases. ***Information Sciences: An International Journal.*** New York: Elsevier, Vol. 29, No. 23, 115-126.

Wildavsky, Aaron. (1969). Rescuing Policy Analysis From PPBS. ***Public Administration Review.*** Washington: American Society For Public Administration, Vol. 29, No. 2, March-April, 189-202.

———. (1975). ***Budgeting: A Comparative Theory Of Budgeting Processes.*** Toronto: Little, Brown & Company.

———. (1979). ***Speaking Truth To Power: The Art And Craft Of Policy Analysis.*** Toronto: Little, Brown & Company.

Wilensky, Harold L. (1971). The Road From Information To Knowledge. ***Information And Technology In A Democracy.*** (ed) Alan F. Westin, Cambridge: Harvard University Press, 277-286.

Williams, Gregg & Mark Welch. (1985). A Microcomputer Timeline. ***Byte: The Small Systems Journal.*** Peterborough: McGraw-Hill, Vol. 10, No. 9, September, 198-208.

Williams, Martha E. (1985). Electronic Databases. ***Science.*** Washington: American Society For The Advancement Of Science, Vol. 228, No. 4698, April 26, 445-456.

Wills, Russel M. (1979). ***Research, Development And Communication In The Canadian Economy.*** Montreal: Gamma, April, 1-71.

Wilson, Gerald A. (1983). Smart User Interfaces For The Distributed Information Environment. ***IEEE 1983 Eascon.*** New York: Institute Of Electrical And Electronic Engineers, 377-385.

Wilson, Stephen. (1977). The Use Of Ethnographic Technique. ***Review Of Educational Research.*** Washington: American Association Of Educational Research, Vol. 47, No. 1, Winter, 245-265.

Young, T. R. (1983). Who Works At Workstations? ***Datamation.*** New York: Technical Publishing, Vol. 29, No. 4, April, 169-174.

Zuboff, Shoshana. (1982). New Worlds Of Computer-Mediated Work. ***Harvard Business Review.*** Cambridge: Harvard University, Vol. 60, No. 5, Sept.-Oct., 145-152.

Appendix A

Time Line

Administrative Computers And

The British Columbia Public Education System

Year	Event
1946	Ministry creates Division of Tests, Standards and Research – Dr. Clifford B. Conway is the first Director
1947	Division abandons electric machine scoring of tests after trials
1950	Hand scoring of 31,480 examination papers
1961	Division's in-house IBM 650 computer "partially mechanizes" scoring of 63,000 matriculation examinations. *Probably first in-house computer in the British Columbia Government*
1963	IBM 1620 computer replaces IBM 650. Two years required to rewrite 650 programs
	Vancouver School District uses UBC mainframe to schedule secondary school classes
	Department of Finance (Ministry of Finance) computerizes accounting system
1966	B.C. Research Council completes preliminary work on an IBM 360 program which forecasts school enrolment
1968	All regular Ministry non-scholarship examinations are entirely objective to facilitate computerized scoring
	Examination scaling on the IBM 360-30
	Vancouver School District is first in province to install an administrative computer
	Report commissioned by Educational Research Institute recommends Regional Educational Data Processing Centres. At year end, eighteen school districts use some form of electronic data processing equipment or service

Year	Event
1968	Columbia Computer Systems Limited introduces a centralized computer batch service for course scheduling and student marks
1969	B.C. School Trustees Association presents brief to Minister urging immediate action on regional educational data processing centres, July 11; no action taken by Ministry
1973	First use of BCRC student enrolment computer model
	Regular grade twelve provincial examinations end in June
1974	Research and Standards Branch divided into three branches: Learning Assessment, Information, and Educational Data Services
	B.C. Research Council's first formal computer run of Teacher Demand And Supply Model
	Dr. Conway, Director of Research and Standards retires, December 31
1975	Data Services Branch begins work on new Management Information System
1976	Ministry develops computerized capability for extracting special reports from data bases
	U.S. National Centre for Education Statistics requests data from Ministry
	Woods Gordon report on B.C. government data processing recommends centralization
1977	Ministry releases *Program for a Financial and Administrative Information System*, March
	Apple Corporation sells first microcomputer, June
	System Act proclaimed, September 1, establishing B.C. Systems Corporation (BCSC)

Year	Event
1978	BCSC consolidates all electronic data processing for seventeen ministries and most Crown corporations, March 31
	Ministry of Education loses independent EDP capability – computer professionals dispersed
	Inter-ministerial Committee on Electronic Data Processing Services reports to Minister of Finance, October
1979	Educational Data Services Branch provides an interface between the Ministry and BCSC, government, and non-government agencies
	Responsibility for Universities moved to separate ministry, 1979-80
	Lower Mainland School District Computer Needs Report recommends standardization of equipment, operating system and applications; no action taken
	Ministry collects 50,000 essential documents each year
1980	Three years of radical change to the financial administration of the provincial government commences, 1980-1983
	School boards write to government expressing opposition to proposed *Financial Administration Act*
	Ministry sponsors pilot project – 100 microcomputers for classroom use; cost $200,000
	Price Waterhouse completes favourable study of B.C. Systems Corporation
	Ministry of Finance terminates BCSC development of comprehensive and integrated government-wide network of financial systems – citing complexity and cost
1981	*Financial Administration Act* proclaimed, July 24
	IBM 8100 distributed minicomputer system installed in Publication Services Branch
	IBM introduces Personal Computer, August

Year	Event
1981	Harts Systems Limited offers student management program for Apple II+ microcomputer
1982	B.C. Government's Fiscal Restraint Program begins, March 31
	Ministry announces School District Administration Computer Program, May
	Ministry implements sixteen IBM Personal Computers for administrative purposes during 1982-83 fiscal year
	Treasury Board develops microcomputer support system for capital budgeting for use in all ministries
	BCSC completes single mainframe architecture
	BCSC installs province-wide data communications network (SNA/SDLC); regional centres link Prince George, Kelowna, Nelson, Kamloops, Vancouver and Victoria; some centres equipped with minicomputers
	BCSC provides courses and support for microcomputers
	BCSC converts Honeywell applications to IBM architecture; 268 people log in excess of 100,000 hours; cost 5.6 million dollars
1983	Ministry of Education introduces new Fiscal Framework and Program Budgeting System, July
	Government offers B.C. Systems Corporation for sale, August 31
	Education (Interim) Finance Amendment Act proclaimed, October 26; transfers taxing and budgeting authority from districts to Ministry
	Public Sector Restraint Act proclaimed October 26; permits termination of public sector employees to reduce the size and complexity of operations

Year	Event
1984	Provincial examinations reinstated after nine-year hiatus. EDP support for examinations contracted to ERIBC
	Government retracts BCSC sale offer, April 14; Corporation reorganized
	Columbia Computing Systems Limited introduces personal computer version (PC XT) of its student management program, February; includes class scheduling, marks reporting, and student demographics; this program handles up to 3,000 students using a PC AT
1985	Conclusion of four-year school district administrative computer project
	Minister of Education dismisses Vancouver School Trustees on May 5, and Cowichan Lake School Trustees on May 13, for non-compliance with Ministry's budget guidelines
	IBM consolidates control of micro-, mini-, mainframe computer market and global communications
	Last run of BCRC Teacher Demand and Supply Model; this computer program is shelved pending Ministry of Education funding for redesign as an interactive model
	Japan announces commercial production of one megabyte chip and significant breakthroughs in Fifth Generation Project
1986	School trustee elections called by Minister of Education for Vancouver and Cowichan Lake School Districts, January 30, 1986
	Education (Interim) Finance Amendment Act, repeal anticipated by December 31, 1986
	Revisions anticipated to Ministry of Education fiscal management system
	Vancouver School District conducts trial of sending data tapes to BCRC for production of graduation certificates
	Project Athena at Massachusetts Institute of Technology enters third year

Appendix B

COMPUTER ACQUISITION PROGRAM FOR SCHOOL DISTRICTS

TABLE OF CONTENTS

		Page
1.	Introduction	1
2.	Program Policies	1
3.	Funding	4
4.	Information Systems Plan	4
5.	Equipment Submissions	7

Appendices

A: Treasury Board Directive 6/82

B: Provincial Government Information Systems Strategy

1. INTRODUCTION

The Ministry of Education recognizes the growing demand for information systems technology to service the administrative and educational requirements of British Columbia school districts. It also recognizes that most school districts are unable to move in this direction without funding assistance from the Ministry.

To provide this assistance, the Ministry is setting up a Computer Acquisition Program which is outlined in this document. The major objectives of the program are:

- to provide financial assistance by way of a cost sharing program which may enable school districts to implement in-house computer systems.

- to ensure that costs, savings, benefits and processing methods resulting from the introduction of computer processing can be determined before the decision to acquire a computer is made, as required by Treasury Board Directive 6/82 (see Appendix A).

- to ensure that information systems developed and operated by school districts are technically and operationally feasible as well as compatible with the Provincial Government Information Systems strategy (see Appendix B).

This program is intended to assist school districts in meeting their information requirements through determining whether the acquisition of in-house computer resources could improve the effectiveness and efficiency of their operations. The acquisition of in-house computer systems, on a dedicated or regionally shared basis, should be compared with the use of service bureau facilities in any proposed solutions.

2. PROGRAM POLICIES

The Ministry has formulated the following policies to govern the implementation of the Computer Acquisition Program.

POLICIES

1. The Ministry of Education supports in principle the acquisition of information systems technology by school boards where these technologies can be demonstrated to result in increased efficiency and cost-effectiveness in meeting the districts administrative and educational requirements. The Ministry will support proposals for the acquisition of information systems technology which promote the capability to exchange information and data effectively and efficiently between individual school districts and between school districts and the Ministry, and which are compatible with the policies established under the B.C. Systems Act.

2. The Ministry is prepared to share with school districts capital purchase costs, or lease-to-purchase costs associated with the acquisition and/or operation of information systems technology on the same basis as capital costs are currently shared. Approved capital costs for the initial systems set up including hardware, software and site preparation will be shared in the same ratio as the individual provincial-district ratio on capital sharing. Subsequent annual operating costs will be shared by the Ministry on the same individual provincial-district ratio as the overall district operating budget.

3. School boards will be permitted to acquire and operate information systems technology following approval by the Ministry, and to retain ownership of equipment where financial and management advantage can be demonstrated. All software acquired under Ministry capital cost-sharing arrangements will be owned jointly by the Ministry of Education and the local school district. Districts will make this software freely available to any other school district, upon the request to do so by the Ministry.

GUIDELINES

1. School Boards contemplating acquisition of information systems technology for which the Ministry will cost-share are required by both Treasury Board Directive and the B.C. Systems Corporation to provide evidence of comprehensive Information Systems Plans. These plans must relate to a minimum time period of three years and must demonstrate the economic advantage of the plan.

2. British Columbia Systems Corporation will evaluate Information Systems Plans and equipment requests pertaining to the acquisition and/or operation of information systems technology, and based upon this review, will make recommendations to the Ministry for systems support.

3. The Ministry will establish a Computer Review Committee including representation from school districts, B.C.S.C., and the Ministry. This Committee will review all requests for systems support, the detailed recommendations of the B.C. Systems Corporation, and recommend to the Ministry an annual priority ranking of submissions for funding.

PROCEDURES

The capital cost-sharing program will be phased in in four equal steps between 1982 and 1985. Where available shared capital funding in any one year does not meet approved requests, funding will be established based on the priority ranking of the Computer Review Committee.

Key evaluation criteria will include:

1) Compatibility of the plan with the information systems strategy of the Provincial Government (see Appendix B).

2) A cost justification statement including identification of anticipated long term capital and operating costs.

3) Initial set-up and annual operating costs within acceptable annual range based on district size. For 1982, the overall provincial average for initial set-up costs of $8.00/pupil and for annual operating costs of $4.00/pupil will be used when evaluating plans.

4) Evidence of economies realized through such procedures as sharing of software development costs among two or more districts.

5) The district is making full use of any compatible computer software packages at such time as these may become available from the Ministry.

The Ministry of Education may request a status report indicating all costs associated with the operation of information systems (software and equipment). The Ministry also strongly recommends that each school district regularly review their systems to ensure the continuation of need and adequate service and cost levels. A Systems Evaluation Methodology Handbook is available from the Ministry of Education, Division of Data and Information Services.

3. FUNDING

To obtain Ministry cost-sharing, it is a requirement of Treasury Board and B.C. Systems Corporation, that a three to five year Information Systems Plan be prepared detailing the administrative and educational systems you anticipate starting or operating during the period. This document will be treated as part of the capital budgeting process and will be approved in principle by the Ministry upon the recommendation of the B.C. Systems Corporation and the Computer Review Committee as part of the Ministry's annual Treasury Board submission. The following information has been prepared by the B.C. Systems Corporation to assist districts in the preparation of this plan.

4. INFORMATION SYSTEMS PLAN

4.1 Approvals Required

4.2 Objectives of the Plan

4.3 Budget Requirements and Cost Justification

4.4 Planned Schedule

4.5 Equipment Requirements

4.6 Software Requirements

4.7 Staffing Requirements

4.8 Facilities Requirements

4.9 Operating Costs

The planning for information systems should stem from consideration of the data and information required to support the administrative and educational activities of your district. In order to properly prepare an Information Systems Plan, you must have a set of prioritized organizational objectives and a clear statement of the information required to meet the defined strategic activities.

4.1 APPROVALS REQUIRED

This section should contain a concise statement of all the equipment and software you are planning to acquire or develop, and its relationship to your information requirements. Specific requests for Ministry capital cost-sharing should be highlighted. The Ministry encourages districts to pursue cooperative efforts among several districts in sharing of hardware and/or software, where this can be demonstrated to result in improved cost and operating efficiency. (See also the B.C. School District Administrative Computer Systems Catalogue which lists hardware and software now in use across the Province.)

4.2 OBJECTIVES OF THE PLAN

This section should contain a summary of each objective or achievement you will be working towards to meet your information requirements during the next three to five years.

4.3 ANTICIPATED BUDGET REQUIREMENTS AND COST JUSTIFICATION: BUSINESS CASE

This section should be prepared in the form of a chart indicating the anticipated costs associated with your planned information systems. Equipment, software, staffing, facilities and miscellaneous operating costs for each year of the plan should be stated (see example on page 8 . This section should also state all the benefits which would be derived from the implementation of the plan. All possible benefits should be quantified and compared to the anticipated costs. The 'Net Present Value' method of analysis is recommended. Any intangible benefits should be listed at the end of this section.

4.4 PLANNED SCHEDULE

A graphic schedule of proposed activities, should be included in this section (example on page 9). Each piece of equipment and associated software system must be indicated along with the anticipated installation dates and system life span.

4.5 EQUIPMENT REQUIREMENTS

This section should highlight the type of equipment you anticipate acquiring. You should indicate the relationship of this equipment to your information systems objectives. If old equipment is being replaced, you should indicate disposal plans.

4.6 SOFTWARE REQUIREMENTS

This section should indicate each software system you anticipate installing. The relationship of this software to the information systems objectives should be indicated. You should also indicate whether the software is to be developed in-house or acquired from alternative sources. The Ministry of Education encourages districts to pursue cooperative software acquisition among districts with compatible hardware. Current listings of district hardware and software systems are available in the catalogue of School Administrative Computer Systems prepared by the Ministry. Standard or core administrative software* is expected to include the following

Payroll/Personnel

General Ledger

Accounts Payable/Receivable

Inventory Control Systems

Purchasing/Stores

Acquisition/development of software in addition to these standard applications (eg.: student scheduling, student records, instructional uses) will be supported on the basis of benefits realized plan.

4.7 STAFFING REQUIREMENTS

The number of staff members and their skill levels will probably change when you acquire computerized systems. Plans for the hiring, re-assignment and re-training of staff should be included in this section.

4.8 FACILITIES REQUIREMENTS

During the life of the plan you will probably require some major or minor renovations to your facilities because of the equipment or staffing required. This information should be included in this section along with the anticipated costs.

---

*The Ministry of Education cautions districts to use existing software in these areas and avoid any new developments. This caution is based upon the expectation of changes in these systems by 1983/84 resulting from revisions to the school district financial funding model.

4.9 OPERATING COSTS

This section should contain any anticipated operating costs that may be associated with the system which have not been outlined in the previous sections.

5. EQUIPMENT REQUEST SUBMISSIONS

Information Systems Plans recommended to the Ministry by the B.C. Systems Corporation and the Computer Review Committee and approved in principle, constitute a commitment by the Ministry to share the capital costs of computer equipment acquisition. The specific amount of funding to be shared by the Ministry is determined by an equipment request submission to the Ministry.

A submission must be covered in the District's approved Information Systems Plan before it will be accepted. A revised copy of the Information Systems Plan must be included with the submission if there has been a significant change to the plan.

This document should contain all relevant information concerning the exact equipment proposed and its associated costs. Background data on equipment specifications and financial arrangements should be attached. It should also be indicated how this equipment relates to current and future workload projections.

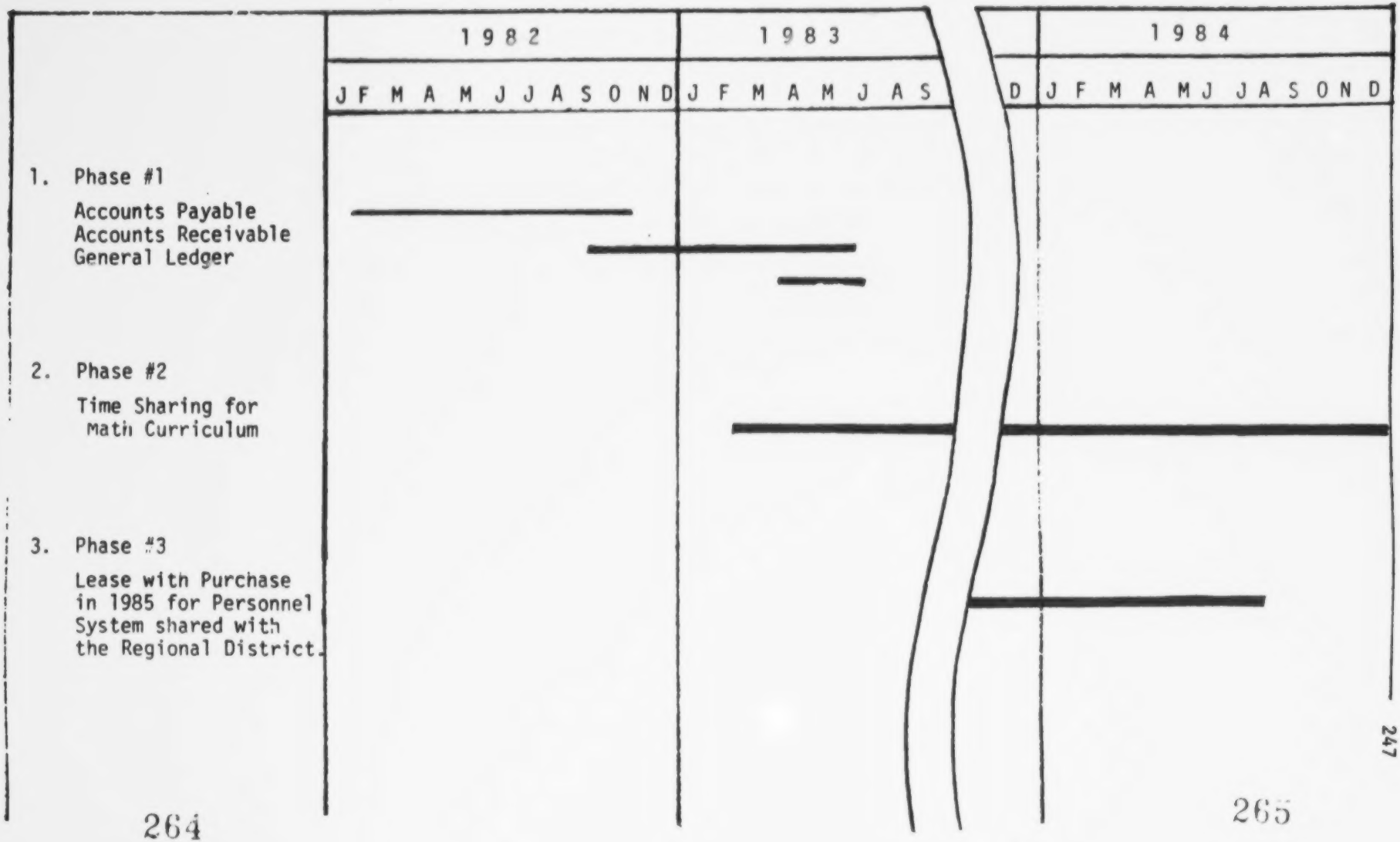
Benefits/Costs Worksheet

	19__ Current	19__ New	Change	19__ Current	19__ New	Change	19__ Current	19__ New	Change
Salaries - Established Temporary									
Professional/Consultative Services									
Staff Training									
Facilities Modifications									
Office Furniture/Equipment									
Materials and Supplies									
Hardware Rental/Purchase									
Software Development/Purchase									
Hardware Maintenance									
Software Maintenance									
Other Expenditures									
Total Expenditures									

Other intangible costs/benefits

INFORMATION SYSTEMS PLAN SCHEDULE

_____SCHOOL DISTRICT


1982
1983
1984
J F M A M J J A S O N D J F M A M J A S D J F M A M J J A S O N D
1. Phase #1
Accounts Payable
Accounts Receivable
General Ledger
2. Phase #2
Time Sharing for
Math Curriculum
3. Phase #3
Lease with Purchase
in 1985 for Personnel
System shared with
the Regional District

247

Province of British Columbia

BUDGET AND ADMINISTRATIVE POLICY

NEW REVISED	CHAP SEC PAGE
	25.1—1
ISSUE DATE	EFFECTIVE DATE
1-Dec-81	1-Dec-81

CHAPTER
25. BRITISH COLUMBIA SYSTEMS CORPORATION

SECTION
1. INTRODUCTION

AUTHORITY	RESPONSIBLE AGENCY
Treasury Board	Treasury Board Staff

25.1 INTRODUCTION

This policy on British Columbia Systems Corporation data processing services documents the approval and monitoring procedures for ministries, the British Columbia Systems Corporation and Treasury Board.

25.1.1 Policy

Ministries may contract for data processing services directly with the British Columbia Systems Corporation, provided funds and services are included in approved ministry budgets.

Prior Treasury Board approval must be obtained for data processing services which deviate from approved ministry budgets if:

- upward variances from the total project development budget, or the operation and maintenance budget exceed the greater of 10 per cent or $5,000, or
- new data processing services are introduced which were not included in the approved budget, or
- new data processing services are substituted for services already included in the approved budget.

The B.C. Systems Corporation recognizes the following System Life Cycle phases:

- Initiation,
- Definition,
- Specification,
- Design,
- Development,
- Implementation,
- Operation and Maintenance.

Prior Treasury Board approval must be obtained for upward budget variances for the following groups of Life Cycle phases if any group exceeds $40,000 and the upward variance from the budget exceeds the greater of 10 per cent or $5,000:

- Initiation plus Definition,
- Specifications,
- Design,
- Development.

Treasury Board will monitor projects which incur such budget variances.

Province of British Columbia

BUDGET AND ADMINISTRATIVE POLICY

NEW REVISED	CHAP SEC PAGE
	25.1—2
ISSUE DATE	EFFECTIVE DATE
1-Dec-81	1-Dec-81

CHAPTER
25. BRITISH COLUMBIA SYSTEMS CORPORATION

SECTION
1. INTRODUCTION

AUTHORITY	RESPONSIBLE AGENCY
Treasury Board	Treasury Board Staff

Prior Treasury Board approval may be obtained by:

- a Treasury Board submission (see section 5.2), or
- the pre-approval process, which requires full documentation in annual budget submissions together with a notification that pre-approval is being sought. (see section 5.2)

Data processing services include the provision of dedicated hardware and software in addition to the regular systems and processing services.

Ministries are encouraged to negotiate fixed-price contracts for Specification, Design and Development phases, if any one phase exceeds $40,000. The Systems Corporation will issue guidelines on fixed-price contracts.

The British Columbia Systems Corporation will offer unit rates by transaction for on-line application systems. Ministries are encouraged to negotiate the use of unit rates by transaction to improve year to year budgeting for their data processing production workloads. Guidelines on unit rates will be issued by the Systems Corporation.

25.1.2 Application

This policy applies to all ministries.

25.1.3 Procedures

Ministries must prepare their data processing services budget in collaboration with British Columbia Systems Corporation. Estimated values, feasibility and acceptability for each service will be determined jointly with the Corporation.

Ministries must submit three costed listings for Treasury Board approval, as part of their annual budgets:

- one for ongoing production applications,
- one for approved projects under development, and
- one for new projects to be started in the next fiscal year. Such projects may be considered for pre-approval, if they are fully documented. Projects which are not fully documented will still require an approved Treasury Board submission, prior to the commitment of funds.

During the fiscal year, ministries must prepare Treasury Board submissions for services considered to be deviations from budget as indicated in section 25.1.1 or for services which could not be fully documented in time for the annual budget submission. Deputy ministers must ensure that these submissions have proper documentation attached.

Documentation for the pre-approval budget process, and for a Teasury Board submission must include the final recommendation of the British Columbia Systems Corporation.

Province of British Columbia

BUDGET AND ADMINISTRATIVE POLICY

NEW REVISED	CHAP SEC PAGE
	25.1—3
ISSUE DATE	EFFECTIVE DATE
1-Dec-81	1-Dec-81

CHAPTER
25. BRITISH COLUMBIA SYSTEMS CORPORATION

SECTION
1. INTRODUCTION

AUTHORITY	RESPONSIBLE AGENCY
Treasury Board	Treasury Board Staff

The British Columbia Systems Corporation and the ministries should carry out joint, periodic reviews on a cyclical basis. Each major, ongoing production application must be reviewed at least once every three years to assess the application's continuing necessity.

Ministries must prepare material for the determination of the economic performance of Development and/or Operation and Maintenance projects in excess of $100,000. During the 1982/83 budget preparation process, detailed procedures for applying the business case criteria will be issued by the Deputy Secretary, Treasury Board. Any of the applicable business case criteria including return on investment methodology, issue of re-investment of savings within the ministry, and other acceptable criteria for assessment of intangible benefits may be employed.

Ministries shall carry out follow-up reviews to monitor actual results versus the business case projection. Ministries may be required to submit business cases for Development and/or Operation and Maintenance projects in excess of $100,000 and for projects that exceed the allowable variances as defined in section 25.1.1.

Disagreements between ministries and the British Columbia Systems Corporation concerning budgeting for data processing services, funding or Treasury Board submissions may be referred to Treasury Board for review and adjudication.

APPENDIX B

PROVINCIAL GOVERNMENT INFORMATION SYSTEMS STRATEGY

The British Columbia Systems Corporation (B.C.S.C.) has established a technological information systems strategy on behalf of the Provincial Government. This strategy promotes the adoption by Government and government entities of a single computer system architecture based upon IBM compatibility.

It is important to emphasize that the strategy espouses IBM compatibility and not IBM products per se. This strategy ensures the availability of the maximum number of functional alternatives while at the same time providing for overall consistency of technological directions. At present a major component of the technological strategy is compatibility with the IBM network architecture - Systems Network Architecture (SNA). The Network information pamphlet which follows provides details.

BCSC SHARED NETWORK

B.C. Government Ministries are decentralizing their operations, as well as moving to online computer systems. This necessitates access to BCSC central processing services from a variety of terminals located in government offices throughout the Province. In the past, different terminal types each required their own unique data transmission lines to a host computer. The cost was prohibitive for most B.C. locations. The BCSC Shared Network is based on a standardized data communications protocol, Synchronous Data Link Control (SDLC), being adopted by several terminal manufacturers. This permits the consolidation of transmission lines at specific points (called Regional Network Centres or RNC's) and the shared use of trunk lines from the RNC to the host computer.

The choice of location for an RNC is primarily dependant on the geographic distribution of online terminals. Locations have been planned to accommodate the forecasted requirements of several cities and their surrounding localities. Effective 01 October 1981 RNC sites were established in Victoria, Vancouver, Prince George, Kamloops and Kelowna. Additional locations will be added as required and justified.

Terminals which use the Shared Network for delivery of BCSC host processing services will realize significant savings in data communications costs. Clients will only be charged for their connection to the nearest RNC. Hence, for most large centres in the province, network costs will not be dependent on the distanct to Victoria.

To be eligible for connection to the BCSC shared network the following criteria apply:

a) The end terminal device must be used for accessing a BCSC mainframe processing service (e.g., IMS, TSO, MVS/JES2),

b) The end terminal device (or controller) must communicate using the IBM SDLC protocol and be a network supported device.

Under the second criteria, only two devices qualify at present - IBM 3270 and 8100. However, the Corporation has commitments from other suppliers to qualify; namely the NTS 435/445 Distributed Data Entry systems, NTS-76/DATA100 remote batch terminals plus our qualified word processing vendors. In addition, to extend the advantages of this shared network to ASCII asynchronous terminals (e.g. DECwriters), BCSC has installed "protocol convertors" at each RNC. This will allow these keyboard terminals access to the shared network via a local dial number (300/1200 bps) at the RNC location.

Appendix C

Consequences Of Extra-national Capital Outflow Generated By Informatics Purchases On Educational Finance

Increased capital expenditures within the public education system is one of several historically reliable mechanisms by which the British Columbia Government has sustained economic growth. Products used for either constructing or re-equipping schools and school board offices were usually purchased from Canadian, if not from British Columbia manufacturers. The cycle of rising capital expenditures stimulated local commerce. Increased employment and a stronger commercial balance sheet produced a more robust tax base which could be tapped to finance greater public expenditures – including education.

The key element of this economic strategy is the purchase of domestically manufactured goods, including lumber, telephones and electronic equipment. For the first time, however, a major capital funding project initiated by the B.C. public school system – the school district administrative computer acquisition project – resulted in the channeling of substantial funds to foreign manufacturers. Most computer hardware and a growing proportion of software used in administrative applications in the school system is manufactured in either Japan or the United States.

The increasing loss of capital to the provincial and national economies indirectly threatens the financial

viability of the education system. As financial support for public education declines, in part a result of a deteriorating economy and a declining tax base, an internal administrative drive for efficiency and financial cutbacks has emerged. To achieve cost reductions, the Ministry of Education has introduced a large-scale computerization program. However, the viability of the provincial economy, on which a large proportion of future educational revenue depends, has as a consequence been further eroded.

Teachers and support staff who become unemployed may either no longer pay taxes or contribute less through taxation to support the school system. Similarly, businesses that depend in part on the province's regular capital inputs for financial growth, encounter hard times when public expenditures are directed increasingly, beyond provincial and national boundaries.

Thus a seemingly innocuous internal administrative decision to improve efficiency may have a deleterious effect on the political and economic system in which the organization functions and upon which it depends.[1] The attainment of increased efficiency may indirectly reduce the long-term success of the organization, as a cascade of events takes place beyond the immediate administrative environment.

The Ontario Ministry of Education computer strategy attempts to counter the loss of capital funds to the provincial economy. The Ministry is supporting the development of

[1] The long-term impact upon students may be manifested as learning deficits.

a provincially designed and manufactured personal computer that can function as an administrative support computer. Ontario has entered into a computer production agreement with the Canadian Educational Microprocessor Corporation (CEMCORP).[2]

[2] CEMCORP has commenced production of a thirty-two bit machine designed according to Ontario Ministry of Education specifications.

Appendix D

The British Columbia Ministry Of Health Expert System

The B.C. Ministry of Health's Executive Management Information System (EMIS) is probably the first electronic support system of its kind within a Canadian provincial government context (BCSC 1981-82:29). EMIS was designed in 1981 for the B.C. Ministry of Health by the B.C. Systems Corporation and provides high-level summaries of a large data base maintained by the Ministry. Executive summaries range from financial forecasts and operational performance to status reports on health claims and hospital grants. These topics are retrieved on menu driven video display terminals. The Minister, Deputy Minister and other senior administrators have desk top terminals through which they can access in one minute what previously took two weeks (BCSC 1981-82:29).

The rapid response time of EMIS makes it an important administrative aid for the decision-making process on health care policy. The Minister appears to have been the first in the British Columbia cabinet to install a computer in his office.

Appendix E

The Informatics System Of The Quebec Ministry Of Education

The Quebec Ministry of Education has achieved a well organized and centrally directed administrative response to the electronic data processing needs of the province's educational organization. Quebec's educational administration informatics system is one of largest and most complex of its kind in the world (Kirby 1983:1). Clients include schools, school districts, and teacher and school trustee organizations.

The Ministry's first computer network was established in 1968 to serve the Ministry of Education and twenty school districts (Ball 1984:38). By redesigning the original highly centralized network and including some advanced technology, the Ministry has produced a contemporary informatics system that responds well to local demands, but at the same time sustains the Ministry's role as the final authority on computer policy.

Political and commercial considerations prompted Quebec to make an early commitment to a computer-based information system. Predominantly French speaking, but surrounded by an English speaking majority, the Quebec government had a strong mandate to guarantee the province's cultural heritage. Throughout the 1960's and 1970's, the provincial school system underwent administrative changes that favoured increased state control (Behiels 1985:149-174). The

establishment of a centralized provincial computer network enhanced the process of administrative consolidation. The Quebec Ministry of Education's commitment to computerization was also prompted by the failure of private software firms to enter this specialized market. Since the market was too small to attract private firms, direct government involvement was required.

A star architecture was selected for the original 1968 network comprising twenty terminals connected to a single central processor. All terminals were dependent on the Ministry's host for data storage and computing power. By 1975, a second Ministry-based mainframe was added to service an additional forty-five districts (Ball 1984:38), but the star topology remained essentially unchanged.

A 1977 projection of future demands showed that at the accelerating rate of hook-ups, the mainframe eventually would have to support more than two thousand administrative terminals (Kirby 1983:1). Since the mainframe's capacity would also have to accommodate cyclical user peaks corresponding with province-wide student reporting and course scheduling deadlines, such a system would be under utilized during much of the year.

The main node of the 1982 bus ring network is an IBM 3081 mainframe installed in the offices of the Quebec Ministry of Education (Ball 1984:38). Today, stand-alone Burroughs computers are in many districts and some of the larger schools, but each machine is integrated into the

provincial network. An IBM 3081 handles the applications that require massive computing power, such as student scheduling and payroll. In early 1982, the mainframe served a total of one hundred and thirty-two online school organizations (Ball 1984:38). Distributed nodes included terminals as well as minicomputers and personal computers selected from the Burroughs B1855 and B1985 series. In 1983, these nodes were located in forty-five school districts (1984). District data processing was frequently independent of the Ministry.

The Quebec Ministry of Education has developed a computer network based on a bus-ring design that services more than two hundred and fifty school districts. Most distributed computers and their peripherals conform to a Burroughs standard network architecture. Standardization helps to ensure that data and software can be readily exchanged between organizational units. The network design is flexible. Large school districts with special data processing requirements can modify Ministry software.

Terminals are also located in some of the larger Quebec schools, with enrolments of 2,500 students or more. The inclusion of school terminals adds a tree topology as a subset of the bus ring network design. Since 1982, there have been increasing demands for school-based personal computers which are being met by the school districts. All schools connected to the Ministry's informatics system are part of a large interactive student management system. When

a student transfers to another school in the same district, or to a school in a different district, the student's dosier containing health counseling, achievement, and attendance records can be transferred electronically.

A separate division of the Ministry, the *Direction des Services Informatiques aux Reseaux*, is responsible for collective software development (Quebec 1983c). Software is distributed via the computer network to all school districts.

In October 1984, Chambly School District located in Longueuil, Quebec had an enrolment of 20,500 students and an operating budget of 106 million dollars.[1] Over one million dollars, approximately one percent of the budget, was channelled toward administrative informatics. District offices were served by one Burroughs B1985 with two megabytes of memory and a B1990-DP with two megabytes of memory. A large secondary school with 2,500 students was awaiting installation of a B25 minicomputer.

Chambly school district had eighty-six terminals, twenty-one remote printers and twenty administrative microcomputers distributed among its schools. All school-based terminals were linked to the district via a star network. Some administrative microcomputers were connected to local area networks. Electronic mail was sent over the system between: 1.) schools and the district office, 2.) the district and other districts, and 3.) the district and the

[1] Information for the Chambly School District is drawn from October 18, 1984 personal correspondence.

Ministry. Electronic mail could not be sent between one district and the schools of another district.

The Ministry of Education has the capability to electronically access all of Chambly's databases, but such access is not allowed. Student grades and other records are transmitted from the schools to the district head office.

By exerting a strong influence over the design and implementation of electronic data processing, the Quebec Ministry of Education has assured that the Ministry's information system is compatible with computer installations at all organizational levels. Operating expenses have been kept relatively low. Software development and updating costs have been minimized. This new electronic information network combines the best features of centralization, for example, standardized hardware and software, with the best of decentralization, such as adaptability to local needs and fast terminal response time.

Appendix F

Schedule Of Questions
(list was modified following the first interview)

A. Preamble

1.) University policy requires that I ask the following: "Have you read and understood the consent form?"

B. Personal History

Here are a few questions which deal with your personal involvement in education:

1.) How long have you been employed in the public school system?

2.) Would you break this period down into components involving that of teacher, principal superintendent, etc.?

3.) How long have you held your present position?

C. Computer History

The remainder of the interview will focus on four areas:

1.) financial implications

2.) centralization/decentralization issues

3.) employment relations

4.) general impact.

Unless otherwise specified, my questions on computers imply an administrative context. However, if you wish to extend your answer to include some educational aspects of computers such as CAI and CAL, please do so.

D. System History

1.) How long has this district used either a computer or a computing company for administrative purposes?

2.) How has computer use changed over time?

3.) What is the age of the current system?

4.) What is the manufacture and model number of this system?

5.) Does the District own or lease the hardware?

6.) Does the head office have a separate word processor?

7.) Do any of the schools have word processors for administrative use?

8.) How many terminals are there?

9.) What kind of networking exists?

E. How Is The System Used?

1.) How is the system used?

2.) Analysis: Finance, Productivity, School and Teacher Achievement?

3.) Monitoring

4.) Word Processing – separate system

6.) Data processing

7.) Finance

8.) Printing/publishing

9.) Conferencing-communication

10.) Planning

11.) How many school principals are using micros for administrative purposes?

12.) What are the plans for the future?

F. Operating Costs

1.) What are the capital and operating costs of your administrative computer system?

2.) Does the district: (a) own, (b) lease, (c) contract-out?

3.) Are there provinicial funds designated for computer acquisition and development?

4.) Have overall reductions in provincial support to public education affected the acquisition or development of the computer system?

5.) How was the software acquired?

6.) Was the software custom designed, or off-the-shelf and adapted?

7.) Do you know of any other districts who use the same hardware/software?

8.) Is there a combination of minis and micros?

9.) Can the system be accessed through distributed terminals i.e. network?

10.) How many terminals in the (a) head office, (b) schools, (c) other?

11.) Does the District belong to B.C. Telephone's electronic mail service (Envoy)?

12.) Are there any plans for subscribing to Envoy?

13.) What is your view of the role of electronic mail?

14.) How have Ministry policies affected the development of your computer system?

15.) What were the capital costs of the system?

16.) What are the operating costs?

17.) Does the Province make funds available?

18.) Development costs?

G. Personal Experience

1.) What has been your experience with computers?

2.) Do you have a terminal (micro) in your office?

3.) Who does the word processing?

4.) How has electronic information technology changed your role as an administrator?

5.) Control vs. controlled. Freedom to exercise judgement?

6.) Horizontal vs. Vertical communication?

7.) Do you intend to obtain a terminal or micro?

H. Employment

1.) How has electronic information technology (EIT) changed the nature of employment?

2.) Layoffs, terminations? How many achieved? How many anticipated?

3.) Old positions/ old job descriptions vs. New positions/ new responsibilities?

4.) Are changes in the nature of employment anticipated?

5.) Loss of skills?

6.) Quality of working life?

7.) Educational origins of new/old personnel?

8.) Promotion?

9.) Part time or reduced work week?

I. Centralization And Decentralization

1.) Has power shifted within the provincial education organization?

2.) During the time that you have been employed in B.C. education, has the organization moved toward either greater centralization or decentralization?

3.) At what level has this trend had the greatest impact?

4.) Will the trend continue? How?

5.) During the last year, there were instances of the Ministry going directly to principals for information that was once obtained through District Offices. Have you heard of this practice? Why is it necessary? Has this happened to your district?

6.) What is the optimal level of decentralization/ decentralizaion for the B.C. public education system?

7.) Does the optimal level vary with the organizational level, i.e. school district, ministry?

8.) How have computers and other forms of electronic information technology affected the centralization/ decentralization process?

9.) Is there something intrinsic to this new information technology which drives centralization/ decentralization?

10.) How could computers be used to support the optimal level of centralization or decentralization that you desire?

11.) Does the type of computer (main, mini, micro) make a difference?

12.) What about software?

13.) And networking?

14.) Which of the following organizational models represents the greatest degree of decentralization: the community school or school-based management?

15.) How does the degree of centralization/decentralization compare with other provinces, and the United States?

15.) What will the future bring?

J. Assistance With Research Design

1.) Are there some people in your head office or your district who will help with this project?

2.) Do you have an administrative computer co-ordinator?

3.) Are there some reports, books, articles which you would recommend?

4.) Would you recommend some administrators – either at the school, district, or Ministry level – who would be willing to help?

Notice of Consent

Project Title: Administrative Perceptions Of The Effects Of Electronic Information Technology On Educational Administration

Investigator: Trevor Gibbens

Principal Investigator: Dr. Daniel Brown

Description: This project will investigate the use of electronic information technology and its effects on the administration of primary and secondary education through a series of interviews with professional administrators. The study is in partial fulfillment of a Master of Arts.

Conditions:

1. My participation is voluntary.
2. I have the right to withdraw at any time. My withdrawal will not be prejudicial.
3. I may refuse to answer with impunity.
4. This interview is confidential.
5. My anonymity is ensured. Records will not identify the respondent.
6. Duration of the interview will be one hour.
7. My inquiries concerning the research procedures will be answered by the investigator.
8. I have received a copy of the consent form including attachments.
9. This interview will be tape recorded.

I understand the conditions of the interview which have been explained to me:

_____

signature

_____

date

BIOGRAPHICAL INFORMATION

NAME:

Trevor Gibbens

MAILING ADDRESS:

205 - 6580 Marlborough Avenue
Burnaby
British Columbia V5H 3M1

PLACE AND DATE OF BIRTH:

Canada, October 8, 1947

EDUCATION (Colleges and Universities attended, dates, and degrees):

Bachelor of Education
University of British Columbia, 1982

POSITIONS HELD:

PUBLICATIONS (if necessary, use a second sheet):

AWARDS:

University Graduate Fellowship

Complete one biographical form for each copy of a thesis presented to the Special Collections Division, University Library.

DE-5